APRIL 3, 1958

MACHINE DESIGN

A PENTON PUBLICATION — BIWEEKLY

DESIGN ENGINEERING SHOW GUIDE

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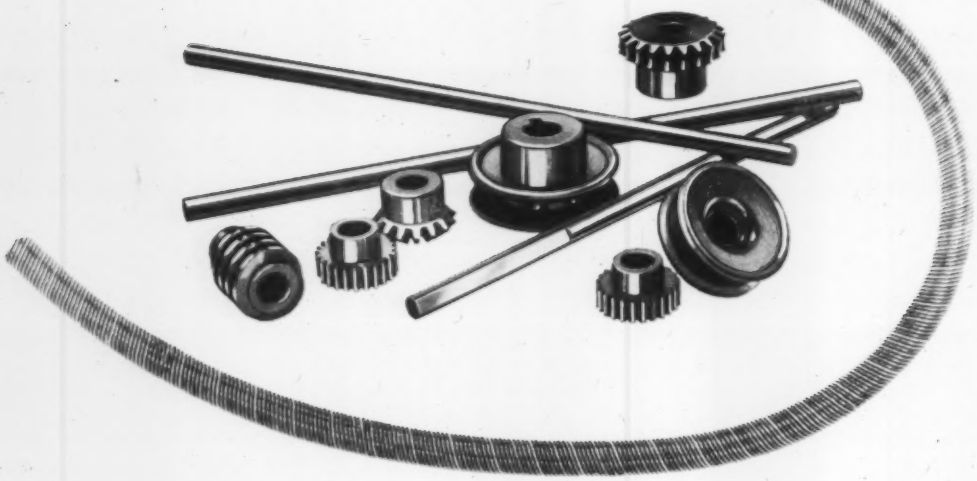
FARNSWORTH

S. S. White

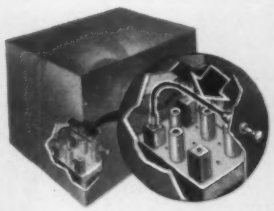
Flexible Shafts Save Space



One small flexible shaft is used in this color TV receiver to connect the hue control to its control knob. And despite the intervening 90° turn, an S. S. WHITE Flexible Shaft enabled the designer to save space by reducing the number of parts needed to ONE SINGLE ELEMENT!

S. S. WHITE Flexible Shafts are now used in hundreds of industrial applications because they simplify manufacturing and assembly operations. They save space and reduce weight . . . cut costs by eliminating gearing, universals and many other parts . . . allow more efficient positioning of controls and controlled parts . . . make servicing easy.

These versatile shafts will do the same efficient job for you, too. If your product involves the transmission of remote control or power drive over a distance of inches to 50 or more feet — consider S. S. WHITE Flexible Shafts. For information and experienced advice in selecting and applying flexible shafts, just write to



S. S. White

FIRST NAME IN FLEXIBLE SHAFTS

USEFUL DATA on how to select and apply flexible shafts! Write for Bulletin 5601.

S. S. White Industrial Division, Dept. 4, 10 East 40th St., New York 16, N.Y. Western Offices: 1839 West Pico Blvd., Los Angeles 6, Calif.

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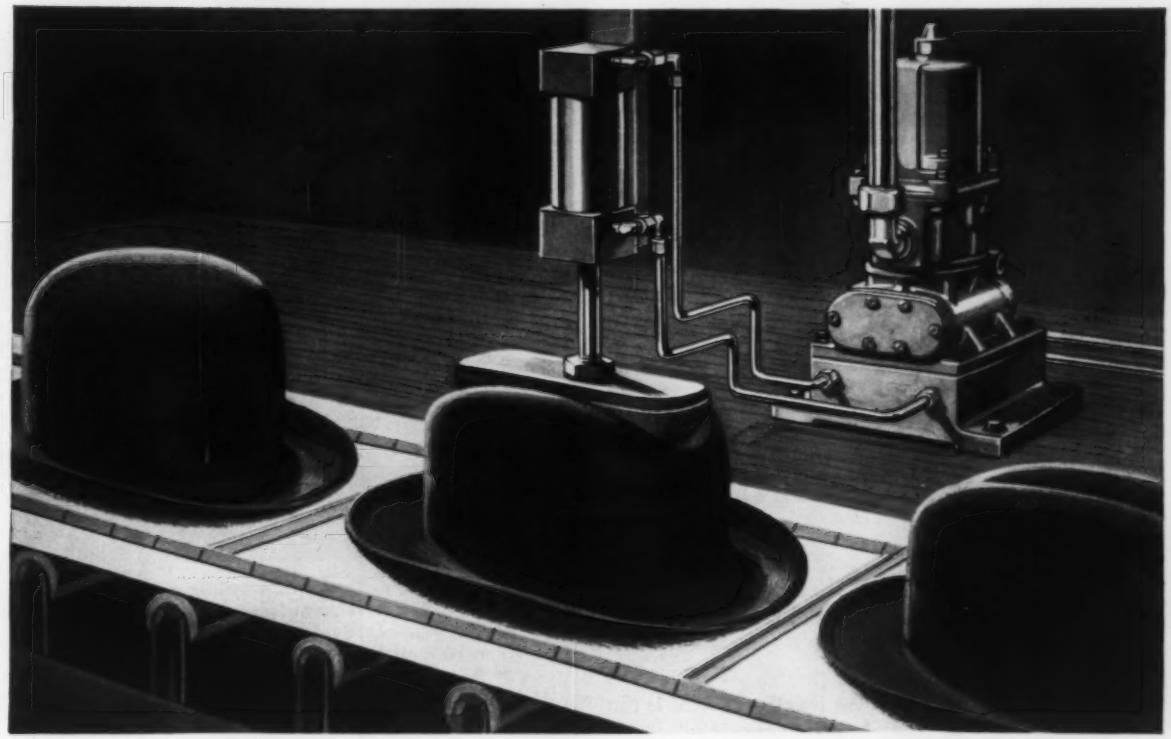
What? A Homburg Dimpler!

Unlikely?...Yes, but...



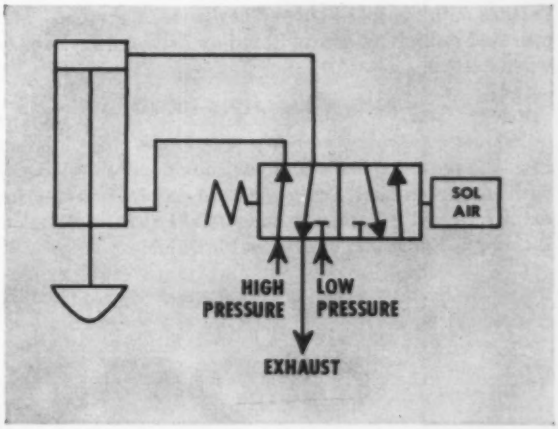
Unlikely? Yes—most men will continue to give the top of their pet fedora a "just-right" push of the fist when they buy it back from the hat check girl. But this little flight into fancy does give us a chance to show a cylinder with a split personality ... able to advance softly, then retreat quickly to get the next hat into position without waste of time. It's made possible with a Ross 4-way, 5-port valve that provides a *different* pressure for each side of the cylinder.

Maybe you have a serious problem that the Ross 4-way, 5-port valve can solve

The same idea of cylinder advance and retreat is put to very real and valuable use in many machines today. Perhaps you, too, have an application where *one* valve controlling *two* pressures will cut production costs. Contact your nearby Ross Service Engineer or write us for details on the 4-way, 5-port valve.

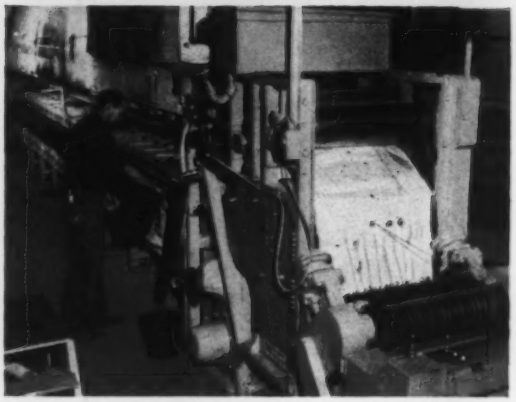
Combining engineering with ingenuity for better air control

ROSS OPERATING VALVE CO.
109 East Golden Gate • Detroit 3, Michigan



1. Solenoid is energized, creaser descends slowly.
2. Solenoid is de-energized, creaser rises quickly.

How V-Belts with the Green Seal save you money



Moneysaving performance is built into every Goodyear V-Belt in exclusive manufacturing processes like those illustrated above. Synthetic fiber cords are impregnated repeatedly with special rubber latex compounds. When treated at a precise tension and temperature for a precise time (the exclusive 3-T process), the cords are stabilized at the point of greatest strength before being built into the load-carrying section of Goodyear V-Belts.

They're dimensionally stable – Exclusive 3-T Cords or unsurpassed steel cables muscle belts that don't shrink or stretch in storage. So matched sets *stay* matched. Down time is cut to a new low.

They're precisely measured – The length you need is the length you get. Mismatching failures are minimized.

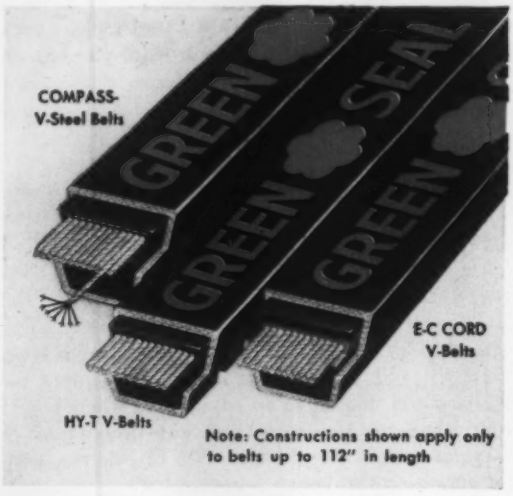
They're high in modulus, low in stretch – Power loss through "creep" is virtually eliminated. Take-ups are few and far between.

They're friction-balanced, non-dusting – Their covers don't grab or stick in the grooves. They run smoothly and cleanly.

They're mildew-inhibited – They're safely stored and operated in high moisture. Stand-by drives always ready when needed.

–AND IT ALL ADDS UP TO

–Maximum trouble-free horsepower hours at minimum cost. It's reason aplenty that you should use only V-Belts with the Green Seal. See your Goodyear Distributor for details. Or write Goodyear, Industrial Products Division, Lincoln 2, Nebraska, or Akron 16, Ohio.



DIMENSIONALLY STABLE V-BELTS with the GREEN SEAL by

GOODYEAR 60th GOODYEAR ANNIVERSARY

THE GREATEST NAME IN RUBBER

Compass, E-C Cord, Hy-T, Green Seal–T. M.'s The Goodyear Tire & Rubber Company, Akron, Ohio

Front Cover: Sine and cosine curves combined with mechanical, electrical and hydraulic symbols form the basis for George Farnsworth's cover. Design Engineering Show Guide, Page 155, provides the theme.

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Getting more service hours per dollar

HOW TO SPECIFY FLEXIBLE METAL HOSE

3 simple steps can help you select metal hose for best results and longer service life

The important job of selecting the *most economical*, the *one right* flexible metal hose for your product or transfer problem can be greatly simplified by following these 3 steps:

1 Send exact specifications

Complete and exact statement of operating conditions will go far in saving you money on flexible metal hose.

First, it assures you that the connector you get will live up to your expectations. And, second, that manufacturers won't bid on hose that's "over-engineered." You'll save in the long run because you'll get the right assembly for every job.

Here is the information we need before we can give you our best suggestions:

A PHYSICAL REQUIREMENTS:

1) *Over-all length (including fittings)*
2) *Diameter (I.D. and O.D.)*
3) *Fittings—size, type, style of thread*
4) *Tolerances permitted*
5) *Quantity required*

B OPERATING REQUIREMENTS:

1) *Material to be conveyed*
2) *Operating pressures—is there shock?*
3) *Operating temperatures*
4) *Movement—lateral and longitudinal*
5) *Vibration conditions?*
6) *Expansion and contraction requirements?*
7) *Corrosive atmosphere?*

Send sketch of proposed installation if available.

2 Use standard metal hose where possible

Many standard connectors have been developed to meet problems common to many finished products—i.e., vibration. Often a standard metal hose will answer your needs as well as a special item could. We can often save you money if we know operating requirements.

3 Call the Man from Anaconda to help you select, specify, test

When selecting or specifying flexible metal hose, you'll find American's staff of trained engineers of invaluable assistance. Their advice and suggestions may help you solve or avoid many costly problems.

NEW INFORMATION

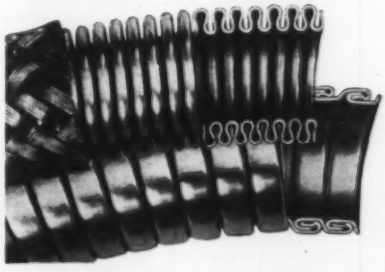
American Flexible Metal Hose and Tubing Catalog puts all the information you are looking for—both technical and general—at your fingertips. Get your copy—today, free of charge. Mail coupon below. 58166S

WHEREVER CONNECTORS MUST MOVE

AMERICAN

FLEXIBLE METAL HOSE AND TUBING

an **ANACONDA®** product



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American Metal Hose Division, Waterbury 20, Conn.

Please send me your free, 60-page Catalog G-560 containing basic information on all types of metal hose and tubing, fittings, etc.

NAME & TITLE.....

ADDRESS.....

COMPANY.....

CITY, ZONE, STATE.....

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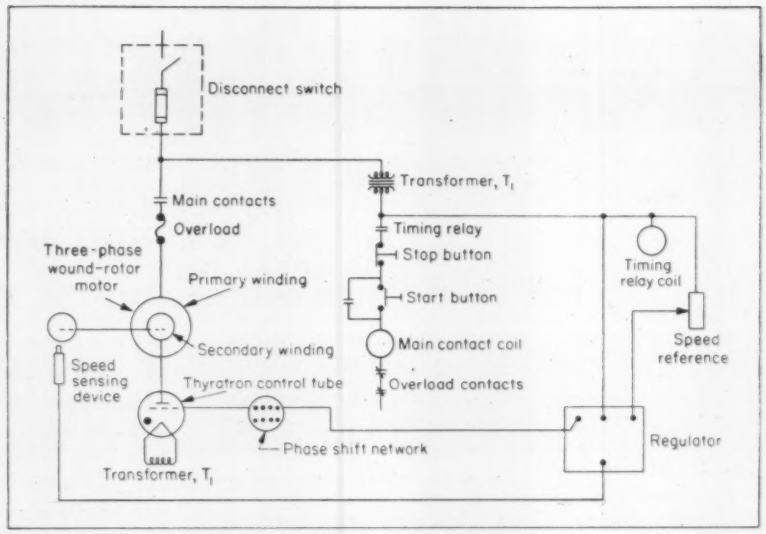
All-AC Vari-Speed Motor Drive Controlled by Thyratron Tubes

Fine or Coarse Performance, As Installations Require

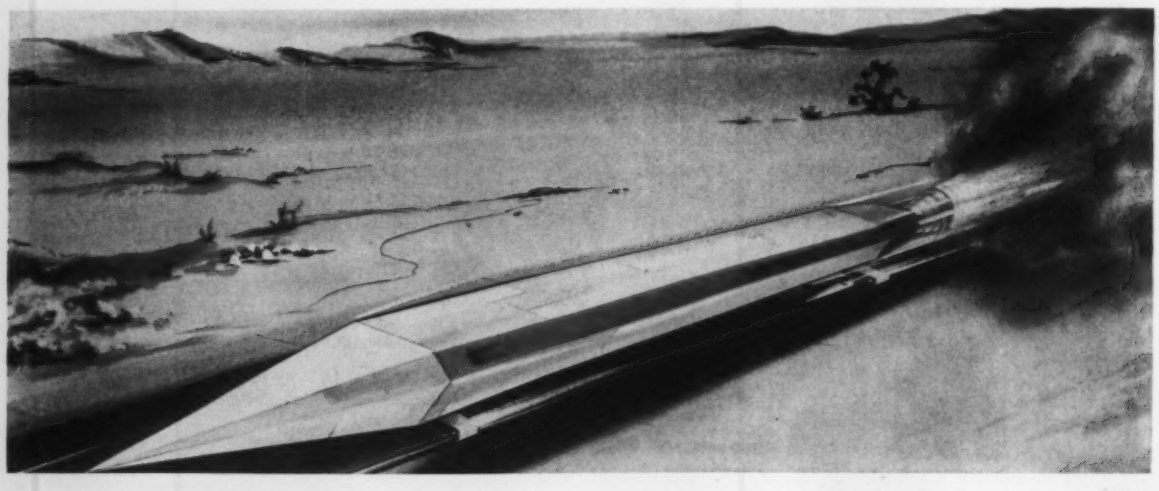
CLEVELAND — Infinitely adjustable speed by means of all-ac electronic control is featured in a new drive for three-phase, wound-rotor, induction motors. Called VarEPack, the drive has been developed by the Electric Products Co. In addition to stepless adjustable speed control, VarEPack demonstrates good regulation and flexibility in a wide range of loads. Low cost and control simplification are claimed advantages over comparable ac-to-dc electronic drives.

VarEPack is a concept rather than a particular product. Installations are tailored to requirements, but systems have essential features in common. In the basic circuit, secondary winding of a wound-rotor motor—hence, the motor's torque and speed—is controlled by thyratron tubes. When the motor primary winding is energized and the speed reference setting exceeds the actual motor speed, the regulator, through the phase-shift network, allows the gas tube to conduct through the motor secondary winding.

This current produces a field which reacts with the field of the



Thyratron tubes control the speed and torque of a three-phase, wound-rotor, ac-motor in the VarEPack system. The motor secondary voltage is matched to the tube voltages and both are capable of carrying large overloads for short periods. All power reaching the tubes must pass through the motor air gap and short-circuit conditions cannot exist. The system is claimed simpler, safer, cheaper than comparable ac-dc systems.



SUPERSONIC SLED, developed by Rocketdyne Div., North American Aviation, will travel 1700 mph on the new seven-mile test track at Holloman AFB. Weighing 7 tons, the pencil-shaped aluminum vehicle is 43 ft long; only 40 in. in height. Its engine develops 160,000 lb of thrust and will accelerate the sled with a force of 15 g. Propellants are forced into the engine's combustion chamber at rate of 5000 gpm

. . . Fluid Power news

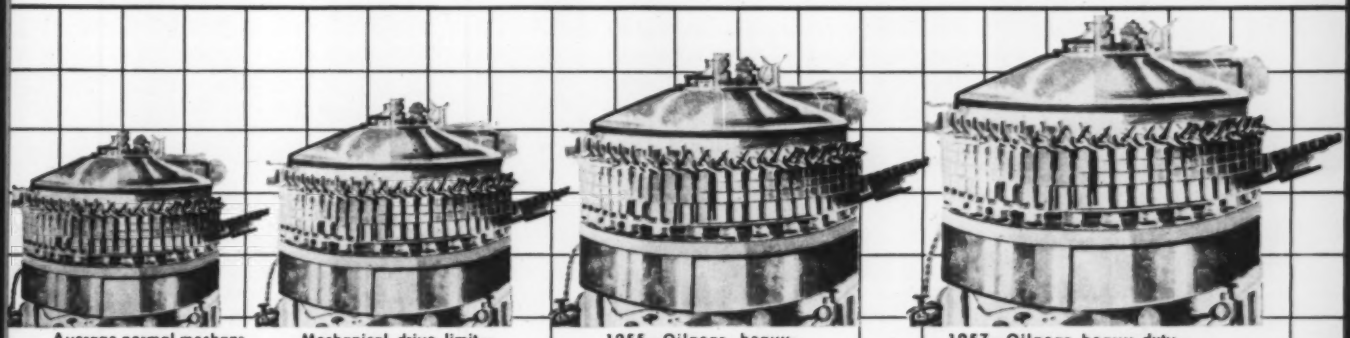
REPORT No. 11,301
HYTAC IMPROVES FILL-CLOSE PRODUCTION

From Oilgear Application-Engineering Files

HOW OILGEAR HYTAC DRIVES IMPROVE FILLER-CLOSER PERFORMANCE—TRIPLE OUTPUT

CUSTOMER: *A Large Food Machinery Manufacturer (Name withheld by request)*

DATA: This manufacturer called upon Oilgear to help solve the problem of producing a filling and closing machine that would exceed the mechanical drive limitations reached when the fill-close rate was increased from 150 to 360 12-oz cans per minute. *Summary of User Requests:* A fill-close rate of at least 425 12-oz cans per minute; accelerate to half speed in 2 seconds—to full speed in 5 seconds without jerky, jack rabbit starts that strain the equipment; reduce spillage and "deadheads"; decelerate to stop in 0.4 seconds; reduce costly losses due to under or overfilling; change speed instantly, easily—with remote control preferred; accurately hold any selected speed regardless of load or electric power variations—viscosity changes; impervious to daily sanitary washdowns; provide trouble-free, low-maintenance, continuous operation.



Average normal mechanical drive—150 12-oz cans per minute.

Mechanical drive limit—360 12-oz cans per minute.

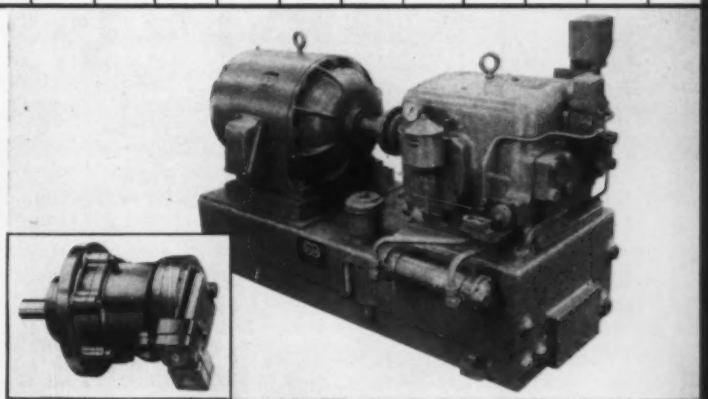
1955—Oilgear heavy-duty, Size 20, Any-Speed HYTAC drive—to 600 12-oz cans per minute with improved performance.

1957—Oilgear heavy-duty, Size 35, Any-Speed HYTAC drive—to 1200 12-oz cans per minute with improved performance.

OILGEAR SOLUTION #1 (1955) Oilgear heavy-duty, Size 20, Any-Speed HYTAC (hydraulic tachometer) drives provided the first step in meeting user requests. These drives on a 6-spindle closer and 60-spout filler smoothly accelerated to full speed in 2 seconds—decelerated to stop in 0.2 seconds; a new, high fill-close rate—to 600 12-oz cans per minute without machine redesign; held *any* preselected speed within ± 0.5% regardless of load, electric power variations or viscosity changes—assuring uniform fill; reduced spillage and conveyor jams. Oilgear heavy-duty HYTAC simplified machine design and reduced maintenance by eliminating slip clutches and electric brakes—and by providing hydraulic cushioning; hydro-dynamic braking; automatic, positive protection against starting and running overloads. Remote, space-saving pump and motor location and completely sealed, leak-tight system provided protection to daily, sanitary washdowns. Users liked this improved performance and speed . . . over 50 similar installations have been made. Some users, however, continued to request higher production rates—with all of HYTAC's advantages.

OILGEAR SOLUTION #2 (1957) Due to the proven ability of Oilgear application-engineered, heavy-duty, drive and control systems to help meet user demands, this manufacturer naturally turned to Oilgear for further engineering teamwork in meeting new, greater production requirements. *RESULT*—new, higher production filling-closing machines that TRIPLE original mechanical drive output—to 1200 12-oz cans per minute with all the same desirable features outlined in the previous installations. One important addition has been made . . . new user satisfaction.

Please direct inquiries to advertiser, mentioning MACHINE DESIGN



This is the newest Oilgear Power-Pak for filler-closers—Oilgear heavy-duty, Size 35 HYTAC drive components. Unit can be remotely mounted and remotely controlled for new performance, new production speed, new accuracy.

Here is but one reason and proof why designers and builders of machinery turn to Oilgear . . . why users recognize and trust the name . . . why more and more this phrase is heard, "For the lowest cost per year—it's Oilgear!"

For practical solutions to YOUR linear or rotary drive and control problems, call the factory-trained Oilgear application-engineer in your vicinity. Or write, stating your specific requirements, directly to

THE OILGEAR COMPANY

Application-Engineered Fluid Power Systems

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ONE-WHEEL "idea craft" created by Studebaker-Packard styling department, is an effort to stimulate new approaches to automotive design. Such projects, say stylists, often result in features adaptable to production automobiles—instrument panel clusters, steering wheels, hub caps, wheel discs, bodies, and seats—have evolved from these idea creations. This particular vehicle would travel on land, sea, or in the air and would be gyro stabilized for land travel. A power receiver mounted atop the rear fin would convert broadcasted ionic or nuclear force into jet thrust during travel on central highways. Clear plastic dome covering passenger compartment could be changed in density from transparency to opaqueness.

motor primary and produces torque, causing the motor to accelerate. As the motor speed approaches the speed reference setting, the regulator reduces tube current, hence motor torque, and the motor no longer accelerates but produces only enough torque to drive the load at the desired speed.

The method of motor cooling is an unusual feature of the VarEPack system. An internal coaxial fan is driven by the magnetic field of the main motor. Since the driving torque for the fan is derived from current in the motor field, the fan operates at a speed proportional to motor current and provides cooling in proportion to needs.

A significant feature of VarEPack is that failure of one or more thyratrons does not render the system inoperative. Replacement may be effected hours, days, or even weeks later if the remaining tubes are not operated beyond their ratings.

Applications of VarEPack include machines which require controlled or adjustable radial acceleration, such as continuous mills for production of metal, plastic, and paper strip. The drive also enables coarse positioning control as in hoists, or precision positioning control, as in machine tools. It permits selection of many different speeds, as required in hosiery looms and in test stands that simulate field conditions.

Human capabilities and limitations as they relate to the design of complex man-machine systems will be the general field covered in the Sixth Annual Human Engineering Institute to be conducted by Dunlap and Associates, Inc., June 10 to 13, at Stamford, Conn. Lectures and discussions will concentrate on basic concepts and newest techniques. Program content will include: Methodology and scientific background of human engineering, systems concept and planning, measurement and experimental techniques, designing for human inputs and outputs. Registration fee is $250. For more information, contact Dr. Roland C. Casperson, director, Sixth Annual Human Engineering Institute, Dunlap and Associates Inc., 429 Atlantic St., Stamford, Conn.

Topics

No litterbug, the space traveler—he'll eat his trash. This is the prediction of Albert Olevitch, Air Materials Laboratory, Wright Air Development Center. He foresees that, since every ounce of material taken on a space flight must be made as useful as possible, containers in which food and other supplies are packed will probably be made of vitamin-loaded, edible chemical films.

• • •

Transistors grow in number of available types as fast as they increase in use—about 600 kinds are now in production. Standardization seems in order for this situation, and the Electronic Industries Association and transistor manufacturers have begun a voluntary program which is already eliminating some of the differences in packaging.

• • •

Morse code in living color—red and green—is being tested by the Navy as a possible improvement in the blinker light signalling system. Since the image of a bright light lingers on the eye's retina for some time after the light has gone out, and since dashes are of three times the duration of dots, speed of flashing-light dot-dash code is only 8 to 12 words per minute. The experimental two-color system, using only dots, has permitted a 25 per cent increase in rate of transmission.

• • •

Cheerleader's dream, a megaphone with ¾-mile range, has been developed by Motorola. The 8-lb device has 15-w power, provided by transistors and six flashlight batteries.

• • •

Our face is read more easily—our type face, that is—beginning with this issue. MACHINE DESIGN is now printed in Cornell type, chosen to replace the former type because of its slightly larger size and easy-on-the-eyes readability. This is 8-point Cornell; articles and features appear in 10-point type.

Special feature in this issue of MACHINE DESIGN is a useful guide to the 1958 Design Engineering Show and Conference. Starting on page 155, the guide includes the program for the Conference, new products at the Show described in text and pictures, a list of all Show exhibitors with booth numbers, and the floor plan of the International Amphitheatre.

Show visitors are welcome to meet the editors of MACHINE DESIGN at booth 112 on the first floor of the Amphitheatre. The MD staff values this opportunity to meet readers in person, to have their comments on MD, and to discuss their writing plans.

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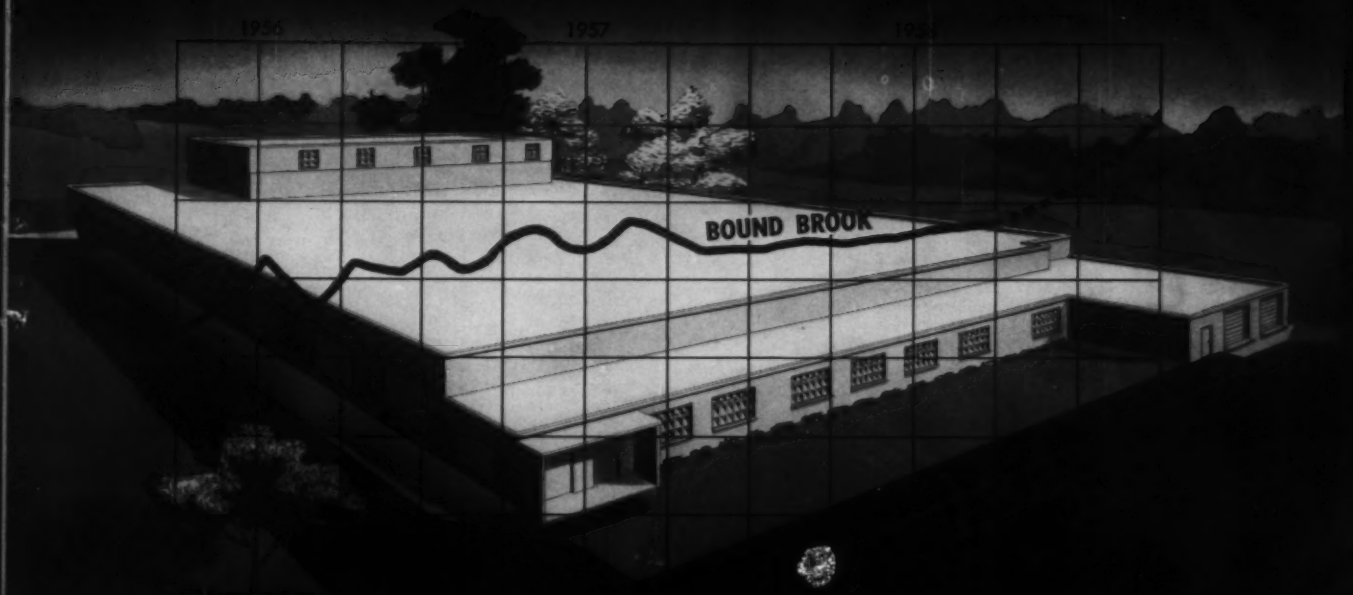
NEWS ITEM No. 4 – 1958 – NEW PLANT IN STURGIS, MICHIGAN



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2. CONFIDENCE IN OUR COUNTRY
3. CONFIDENCE IN BOUND BROOK'S ABILITY TO GIVE THE FINEST SERVICE IN THE FIELD OF POWDER METALLURGY

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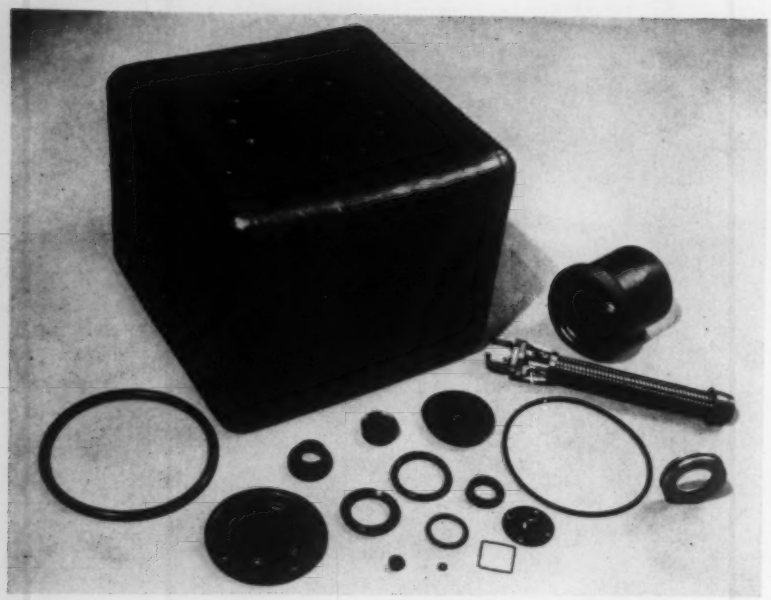


Applications of new Viton synthetic rubber, present and potential, include seals in aircraft and motor truck engines; seals in gasoline pumps. Bladder type fuel cells made of fabric coated with Viton remain intact at 450 F. Coated fabrics may also be used on aircraft firewalls, in missile bladders, in protective clothing. Useful life of steam and chemical hoses may be extended by Viton linings. Solutions of Viton may make good heat-resistant, flexible paints. Viton linings in tanks and pumps give longer life to petroleum and chemical handling machinery

New Synthetic Stays Rubbery When the Heat's On; Cold Too

WILMINGTON, DEL.—Synthetic rubber that stays rubbery at temperatures above 400 F and is also resistant to attack from lubricants, many acids, and aircraft fuels will soon be available in commercial quantities. At Deepwater Point, N. J, Du Pont is completing a plant for volume production of its new, high-performance elastomer called Viton.

In chemical terms, Viton is a linear copolymer of hexafluoropropylene and vinylidene fluoride. It is about 65 per cent fluorine by weight and has a specific gravity of about 1.85. Viton is expensive for the present—about $15 a pound —but its properties put it in a class by itself.

According to Du Pont, no commercial elastomer equals Viton synthetic rubber in resistance to oils, fuels and solvents at temperatures over 400 F. Some plastics do, but they lack the physical properties of Viton, notably its resistance to compression set.

When Viton is exposed to dry heat and tested to failure, the cause of failure is embrittlement. Tensile strength is largely unaffected. When oven aged in air, vulcanized Viton remains usefully elastic for more than 2400 hours at 400 F; 250 hours at 500 F; 24 hours at 600 F.

Machine parts can be made of vulcanized Viton in any hardness from 60 to 95 durometer. At room temperature, tensile strength is in the range 2000 to 3000 psi, and ultimate elongation varies from 100 to 400 per cent, depending on hardness. At 300 F, tensile strength is 300 to 1000 psi and elongation 80 to 200 per cent.

At elevated temperatures, the new rubber has good resistance to compression set. Specimens compressed 25 per cent and held for 70 hr at 250 F recover 90 to 97 per cent of their original dimension.

At low temperatures Viton's properties are not outstanding but adequate for most services. Typical compounds have a Young's modulus of 10,000 psi at − 20 F and a brittle point of − 47 F. Brittle point is affected by specimen thickness. The − 47 F value is obtained on a specimen 0.075 in. thick.

Typical stocks of Viton synthetic rubber have electrical resistivity of 2.5×10^{13} ohm-cm, specific inductive capacity of 16.7, power factor of 4.5 per cent, and dielectric strength of 412 volts per mil.

Du Pont's Elastomer Chemicals Dept. manufactures the raw polymer of Viton, but no finished products. The polymer is sold to rubber manufacturers who process it and fabricate finished products on the same equipment and by the same methods they use with conventional elastomers.

Aircraft Soon to Have More Powerful Fuels

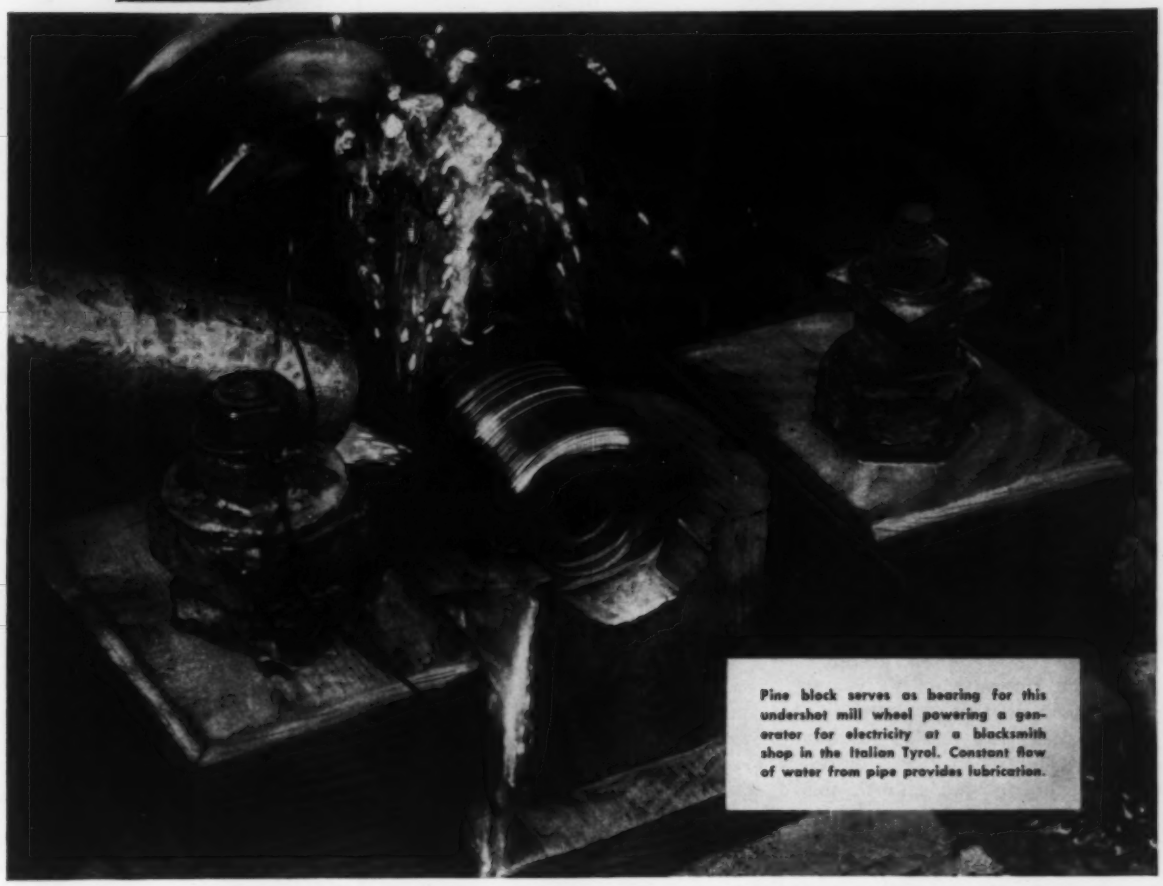
DALLAS—New aviation fuels to deliver longer range with smaller fuel loads will soon be used in civilian and military aircraft according to a report by R. A. Wells, staff engineer for the Gulf Research and Development Co. Several types of fuel are now in production and others are being considered and tested.

Wells noted that the fuels cover the whole range of aircraft from conventional piston engines to liquid-fueled rockets. He claimed that airlines should realize a net saving in operating cost of approximately 3 per cent, not taking account of anticipated savings in engine overhaul cost.

For jet planes, pyrophoric fuels (liquids that ignite spontaneously in air) seem to produce much better overall results than any other type tested to date. Three types of pyrophoric fuels under examination are triethyl aluminum (TEA), triethyl boron (TEB), and Trimethyl aluminum (TMA). They can be produced in large volume at reasonable prices and enable small, uncomplicated engines to deliver the same thrust now obtained from high-performance engines using present fuels.

A ram-jet engine that burns pyrophoric fuel has been designed for constant-altitude target drone or missile application. It weighs only

ND FACTS



Pine block serves as bearing for this undershot mill wheel powering a generator for electricity at a blacksmith shop in the Italian Tyrol. Constant flow of water from pipe provides lubrication.

Is pillow block inefficiency costing your plant money?

The need for relubrication of pillow blocks is *more* than costly today! It's *passé*. For New Departure's new pillow block line is built around the performance-proved Type AE adapter ball bearing with *Sentri-Seals*. Dirt, moisture and wear are sealed *out* . . . grease is sealed *in — for life!* Send for details about New Departure pillow blocks. Ask today for Catalog PBC-A.

These bearings are quickly and easily applied to shafting without special tools. They are positively locked in position with eccentric cam locking collar and set screw.

1908–1958
GM
FORWARD FROM FIFTY

ND NEW DEPARTURE
DIVISION OF GENERAL MOTORS, BRISTOL, CONN.
NOTHING ROLLS LIKE A BALL

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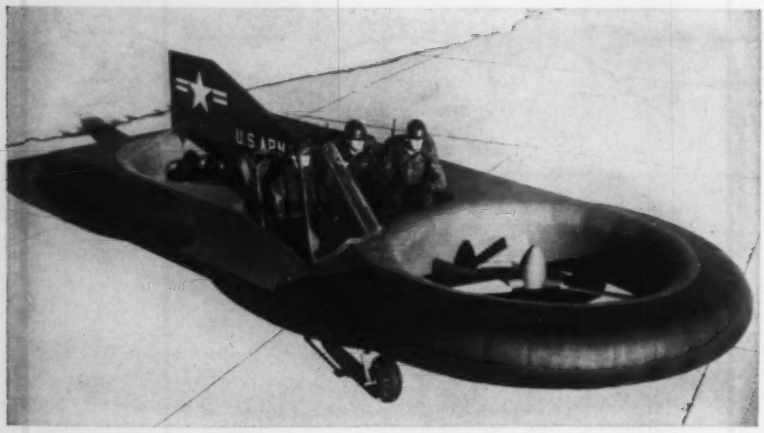


FLYING JEEP, a radical departure from previous VTOL designs, recently passed ground tests and will soon fly, according to Piasecki Aircraft Corp. Built for the Army, the new vehicle will travel on land or rise vertically and fly forward at 150 mph. All major components—dual-engine powerplant, rotors, and controls—are housed in an extremely low chassis, enabling the craft to fly under bridges or wires or behind low objects for concealment. Compact design also permits the vehicle to travel down narrow streets, between trees, other obstacles, like conventional jeep.

18 lb and can develop a velocity of Mach 1.5. There is the possibility of a $600 pyrophoric engine with performance comparable to a similar unit using conventional fuels and priced under $10,000.

Wells admitted, however, that pyrophoric fuels have some unfortunate characteristics. TEA and TEB are extremely destructive to living tissue—cause deep burns and scarring. They ignite spontaneously if accidentally exposed to air and react violently—even explode—in contact with hydrogen compounds. The Navy, particularly, has not looked kindly on materials that react with water.

Registration Open for 1958 Design Show and Conference

Speed Registration with Advance Forms for Show, Conference, Hotel

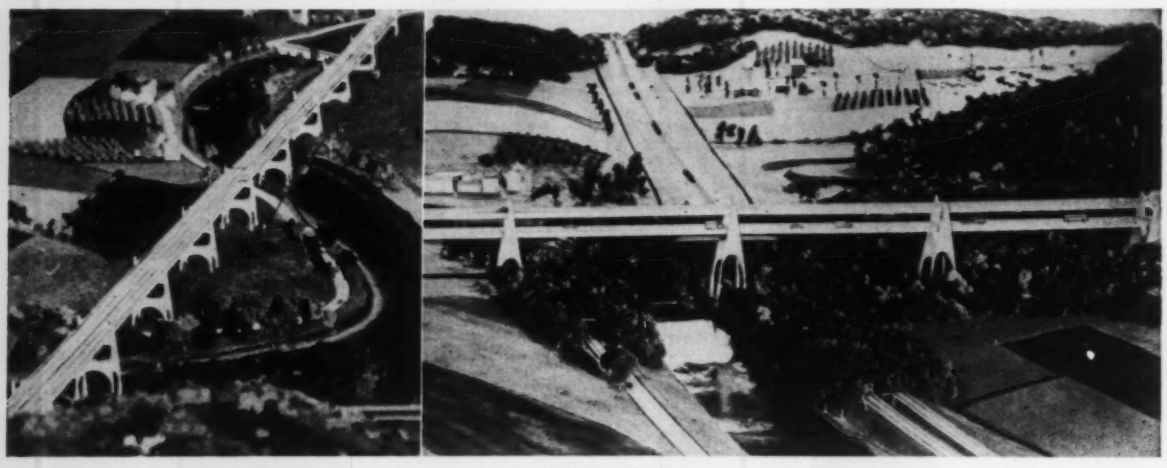
CLEVELAND—Designers who plan to attend the 1958 Design Engineering Show and Conference can speed their registration by filling out Rapid Registration Forms in advance and presenting them at the show. There will be a $2 fee—payable only at the registration desk at the show. Conference information and rapid registration forms should be requested from

Clapp & Poliak, Inc.
341 Madison Avenue
New York 17, N. Y.

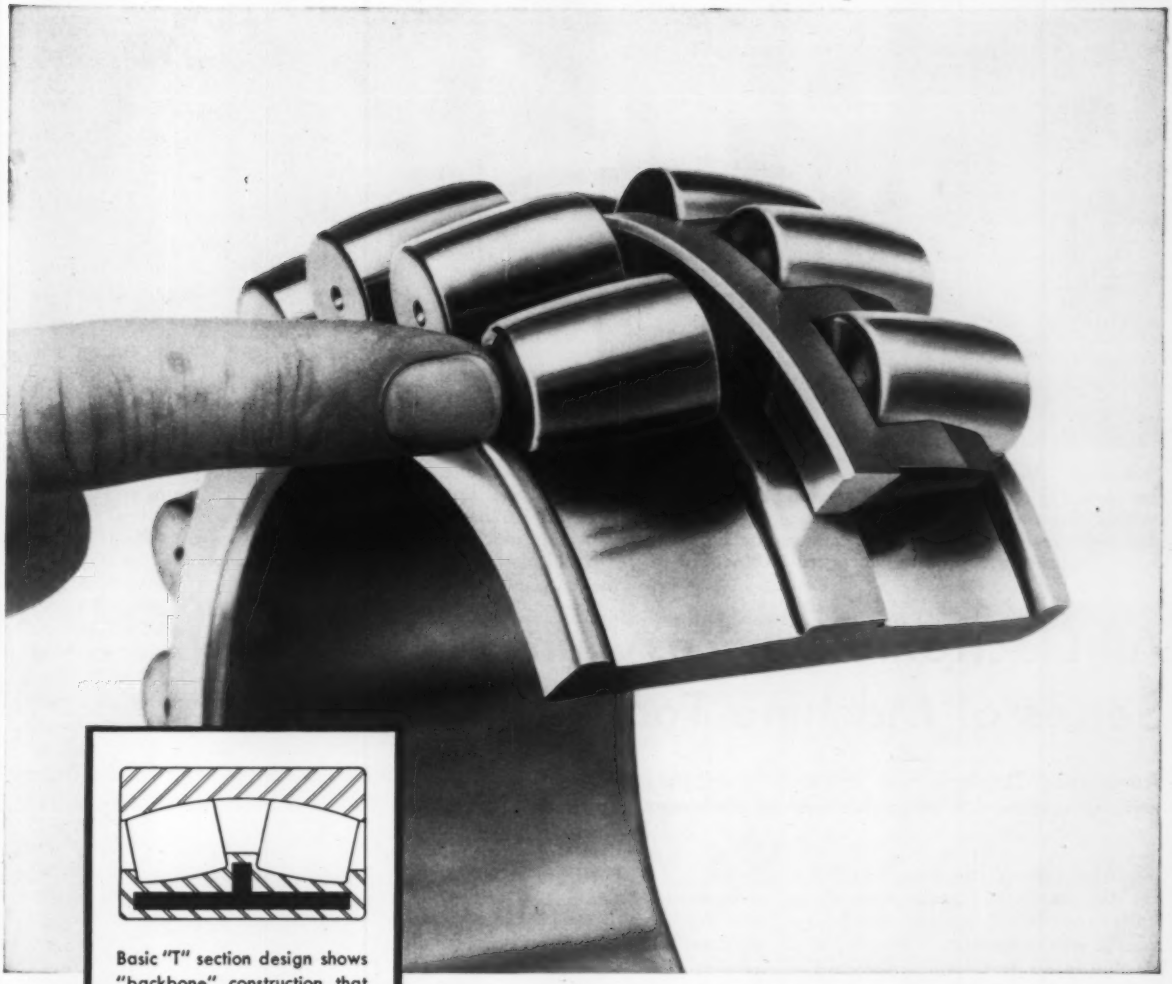
For hotel reservations, specify hotel preference, name of person who will occupy room, date of arrival and probable departure. Mention the Design Engineering Show, and contact

Housing Bureau
c/o Chicago Convention Bureau
134 North LaSalle Street
Chicago 2, Illinois

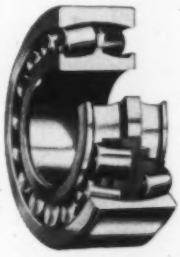
Registration for the conference includes admission to the show. Fee for ASME members is $5; for nonmembers, $10.



ELEVATED SUPERHIGHWAYS WITH MONORAILS beneath them have been forecast for the year 2000 as part of rifle-straight "transportation core in the sky." General Motors president Harlow H. Curtice disclosed this concept will be introduced as an operating model in one of the firm's exhibits at the Brussels International Exhibition of 1958. He said this superhighway-monorail "transportation core" as envisioned by stylists is trilevel. The top two levels are each three-lane, electronically controlled highways. Each level carries traffic one way. Suspended beneath the lower highway is a two-way monorail commuter train system



Basic "T" section design shows "backbone" construction that insures positive roller guidance and stability without skewing under all load conditions.



design engineering show 1958
International Amphitheatre Chicago April 14-17
VISIT TORRINGTON IN BOOTH 736

For roller stability...

there's nothing like "the bearing with the backbone"

The only *positive* way to guide rollers is by an integral center guide flange—backbone of the *Torrington* Spherical Roller Bearing. No floating ring can match it for stability under heavy radial and thrust loads.

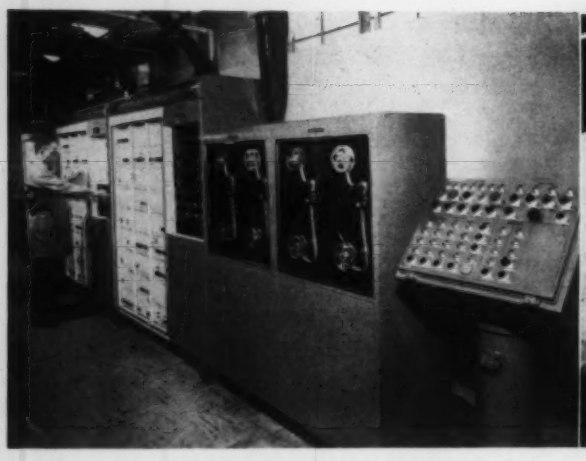
This "bearing with the backbone" insures true rolling motion . . . prevents stress concentration . . . means minimum friction. It makes possible open-end cage design, too, with no shrouds to impede circulation of lubricant to bearing contact surfaces. There is less heating and more positive lubrication.

The integral center guide flange is adapted from the same principle used in the design of Torrington Tapered Roller Bearings. This refinement is typical of Torrington's uncompromising engineering that assures you the ultimate in bearing performance. **The Torrington Company, South Bend 21, Ind.—and Torrington, Conn.**

TORRINGTON BEARINGS

District Offices and Distributors in Principal Cities of United States and Canada

SPHERICAL ROLLER • TAPERED ROLLER • CYLINDRICAL ROLLER • NEEDLE • BALL • NEEDLE ROLLERS • THRUST



Technician checks control cabinets for the "first all-electronically controlled line of machine tools." Viewed, starting from the right, are the master control panel, four tape readers, and control cabinet for boring machine. Technician is looking at control cabinet for drilling machine. Behind him is milling machine control cabinet. Engineer (right) monitors computer "thinking." All information sent to milling, drilling, and boring machines flows through this bank of relays and blinker lights. Design changes follow same path.

All-Electronic Devices Run Series of Machine Tools

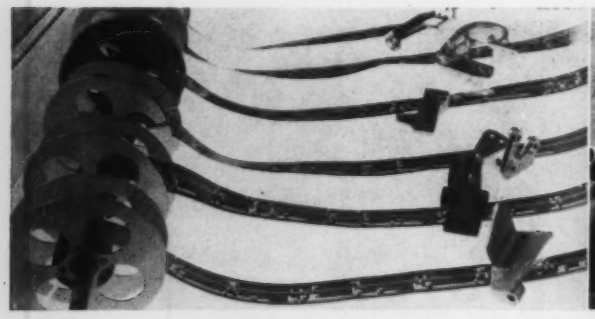
Automation system runs different machines in one line, permits simultaneous manufacture of different products

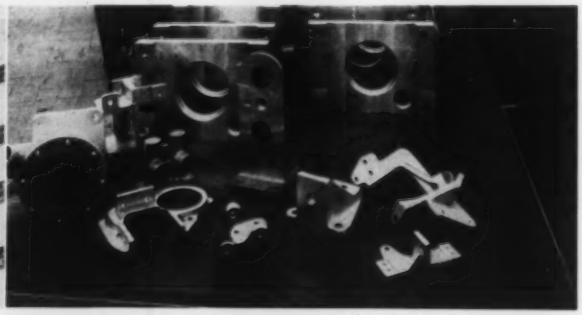
LOS ANGELES—What was described as "the nation's first all-electronically controlled line of machine tools" was recently revealed by Hughes Aircraft Co. The line, operated from punched tapes and controlled by transistorized digital computers, is producing vital parts for the Hughes armament control system, used in all U. S. and Canadian Air-Force interceptors.

"Single machine tools have been electronically controlled in the past, but this is the first successful application of automatic electronic controls to a series of machine tools working on successive operations and, in fact, making a variety of parts at the same time," company officials said. Changes in operations may be introduced or production on new parts started simply by changing punched tapes and without stopping the machines, they explained.

According to the Kearney & Trecker Corp., designers and builders of the machines, the integrated machine line with punched-tape controls is constructed on the modular principle, marking the first time this principle has been successfully applied to electronically automated machine tools. Both machines and controls are constructed to be fitted together as "blocks" in any desired number and arrangement to provide the greatest production savings for the type of parts to be machined. The line may be added to and rearranged from time to time and will still be capable of operation from a single tape for each type of part.

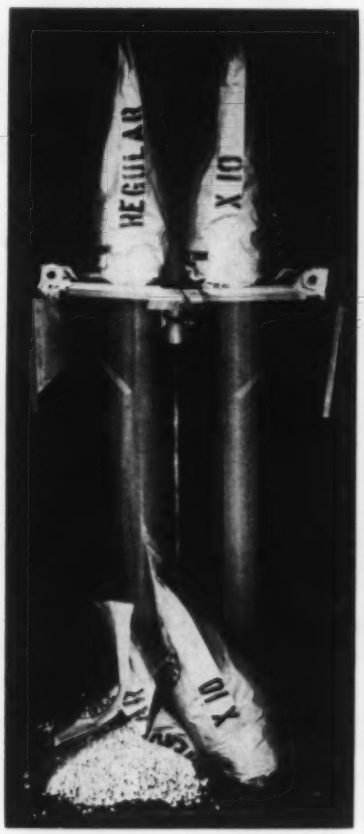
Using the control system to translate a blueprint into finished "hardware" takes a minimum amount of time, Hughes officials pointed out. A planning engineer first takes a product blueprint, and lists dimensions and the proper sequence of machining operations on a simplified planning sheet. A typist next





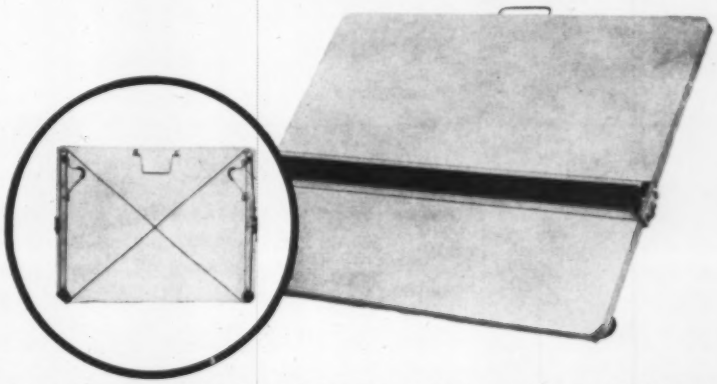
Variety of punched tapes illustrates flexibility of electronic, completely automated line of machine tools. Operated by new electronic controls, machines can simultaneously produce all the parts shown. Duplicated part has been through milling, drilling, and boring machines. All machines fit together like blocks.

transcribes the planning sheet data on punched tape. The completed tape is inserted in a tape-reader in the controls, and the information is fed into the computing "brain" of the system. Using the taped information, the controls give measuring, positioning, and cutting orders to machine tools on the automated line. The human operator needs only to place unmachined castings on the line and remove finished parts, but even this operation can, reportedly, be made automatic.



SPILLED BEANS after 5-ft drop tests reveal sack made of regular kraft paper. Unbroken sack is made of Clupak, stretchable paper recently developed by West Virginia Pulp and Paper Co. The new paper is said to be five times tougher than regular kraft paper. It is being used in multiwall sack, asphalting, waxing, and standard converting grades. Prospective uses include wrappings, impregnated with rust inhibitor, to protect machined parts; cable wrappings, and disposable articles of wearing apparel

DRAFTING TRENDS



This is the new, portable Paraltilt Drawing Unit for engineers and draftsmen. It is especially suitable for field use and for "after hours" projects at home.

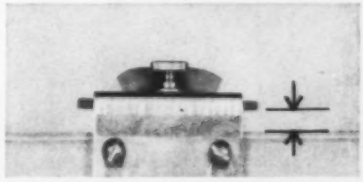
A new portable drawing unit

The Paraltilt is a portable drawing board and straight edge combination for engineers and draftsmen. This unit is designed for use in the field, and for home use as well.

The unit has a beautifully finished maple straight edge with absolutely clear transparent edges. This straight edge is so made that it will not slip or get out of line. It is firmly attached to a satin-finished drawing board. Two self-locking retractable metal leg supports permit use at a choice of angles. The Paraltilt is lightweight and has a formed metal handle for convenient carrying. Paraltilt also offers a handy pencil ledge located right on the straight edge as an added convenience.

Time saving tips WANTED!

POST periodically publishes a handbook of timesaving methods and ideas of engineers and draftsmen. This "Time Saving Tips" booklet is distributed free of charge to all companies and individuals who request it. We would like to enlist your help in compiling material for an entirely new edition now being planned for future publication. Our current book has four sections: *Drafting Shortcuts, Engineering Data Tips, Board Timesavers,* and *Calculating Ideas.* If you have a "pet" method of shortcut, we would certainly appreciate receiving your submission.



Full 1/4 inch clearance eliminates smearing and permits drawing on cardboard and metal.

With a Paraltilt Drawing Unit there is complete action over the whole drawing area—the user has finger-tip control of this well crafted drawing unit. The Paraltilt is available in a wide variety of sizes.

POST'S specialized woodworking facilities

The Paraltilt Unit is made in Post's own extensive woodworking plant in Owen, Wisconisn. Post's comprehensive line of T-squares, straight edges, drawing boards, triangles, curves, etc. are produced at this plant. Each Paraltilt Drawing Unit is precision made and carefully inspected.

For further information on Paraltilt write Frederick Post Company, 3652 N. Avondale Ave., Chicago 18, Ill.

POST

SENSITIZED PAPERS & CLOTHS • TRACING & DRAWING MEDIUMS • DRAWING INSTRUMENTS & SLIDE RULES
ENGINEERING EQUIPMENT & DRAFTING SUPPLIES • FIELD EQUIPMENT & DRAFTING FURNITURE

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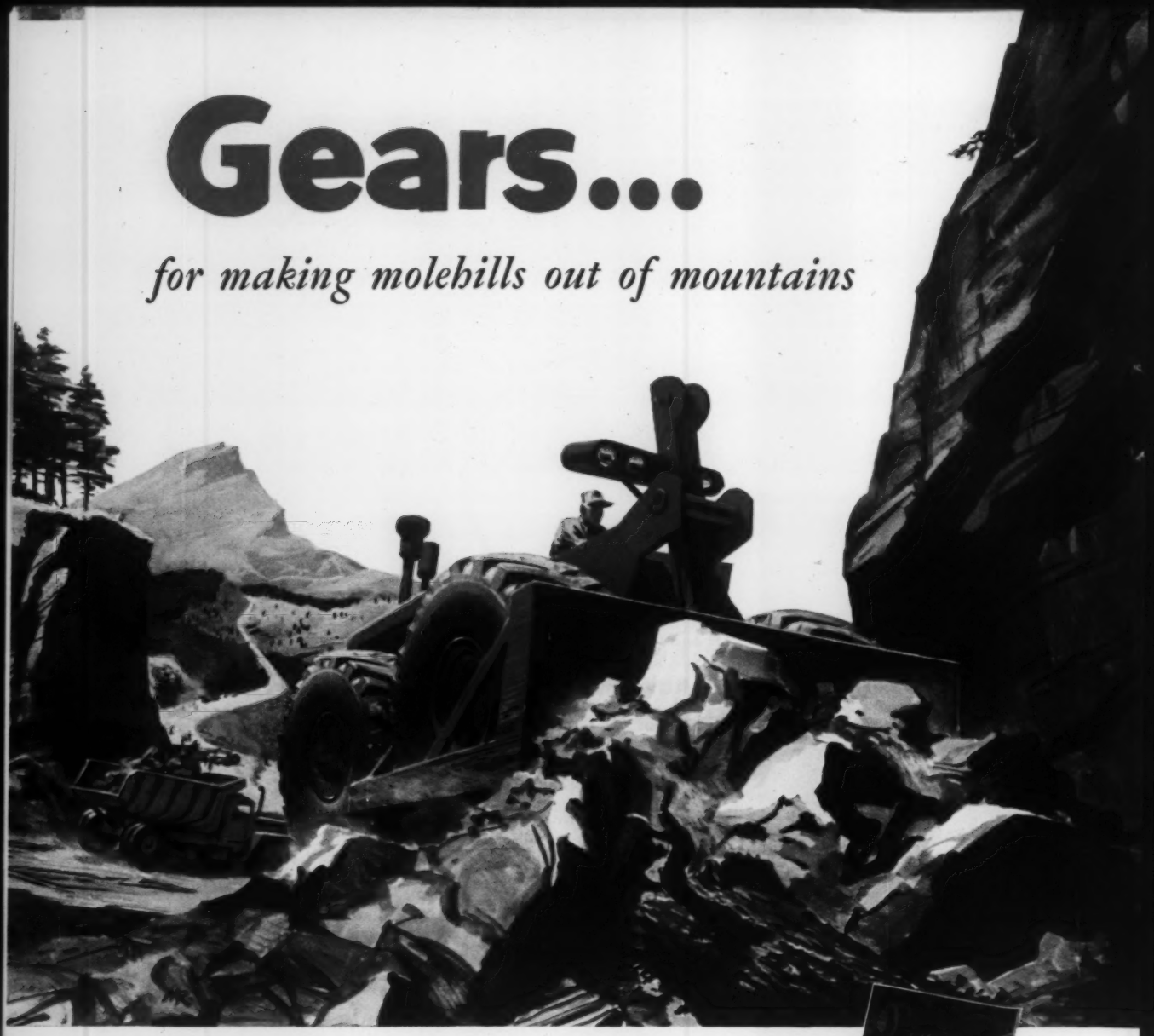
Gears...

for making molehills out of mountains



It is hard to imagine worse working conditions, and that is the very reason why the manufacturers of so many kinds of road building equipment install "Double Diamond" gears. Wherever the going is especially rough, wherever gears must give uninterrupted service on harsh, time-table schedules, you'll find our gears at work.

For low installed cost, for true operating economy and performance, and for buckling down to the hardest kind of service—nothing beats "Double Diamond."

Our salesmen are experienced gear engineers. Why not talk to one about your gear requirements?

May we send you a copy of this comprehensive catalog on the many gear types in which we specialize?

EATON

AUTOMOTIVE GEAR DIVISION
MANUFACTURING COMPANY
RICHMOND, INDIANA

GEARS FOR AUTOMOTIVE, FARM EQUIPMENT AND GENERAL INDUSTRIAL APPLICATIONS
GEAR-MAKERS TO LEADING MANUFACTURERS

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EDITORIAL CLIPSHEETS—So you won't have to "clip" this issue, we'll be glad to send a personal copy of any article as long as the supply lasts. Just fill in the page number and title of article in the place provided on the Yellow Card.

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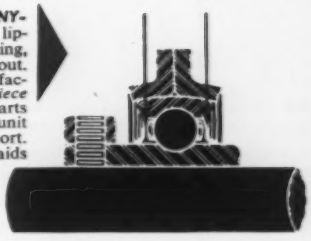
Precision ... self-alignment

EVEN IN THIS LOW-COST BEARING

BEST SEAL AVAILABLE ANYWHERE! Synthetic rubber lip-type seal, integral with bearing, keeps lubricant in, dirt out. Bearing is greased at the factory and shipped in *one piece* . . . no juggling of sundry parts in assembly—simply slip unit on shaft and bolt to support. Its compactness further aids design flexibility.

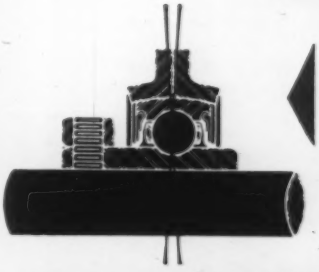


LINK-BELT JPS-200 ball bearings maintain capacity despite shaft and support deflection

In rugged field service, supporting structures on farm machinery and similar equipment undergo inevitable weaving. Shafts, too, are subject to dynamic deflections. Answer: *self-alignment* — the ability of Link-Belt bearings to adjust under these conditions. And it's yours *at low cost* in this precision Link-Belt ball bearing.

Equally important, Series JPS-200 bearings achieve their economy with *no loss of efficiency*. They combine sturdy pressed-steel housings with standard, full-capacity Link-Belt ball bearings.

Folder 2517 has complete data on the Link-Belt JPS bearing series, and Book 2550 covers the entire Link-Belt bearing line. Get both from any of 40 Link-Belt offices.



FREE ROLLING AND FULL LOAD CAPACITY are maintained even under shaft or support misalignment with Link-Belt self-aligning feature. Extra-long inner ring of bearing assures proper load distribution. Heavy spring-locking collar firmly secures bearing on shaft.

LINK LB BELT

self-aligning ball and roller bearings

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville (Sydney), N.S.W.; South Africa, Springs. Representatives Throughout the World. 14,339-A

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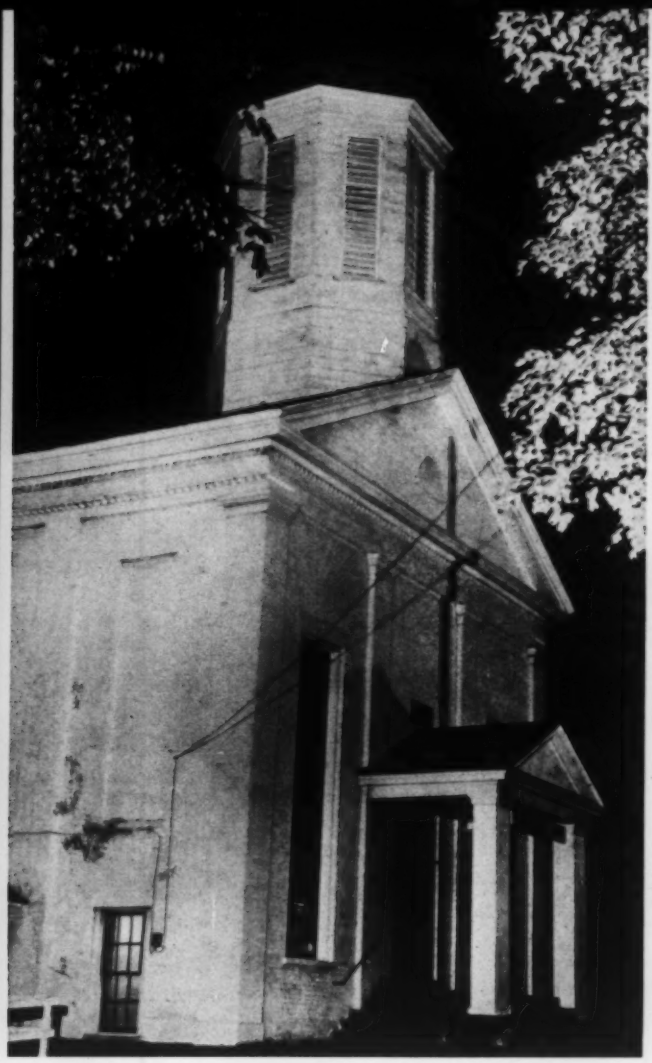
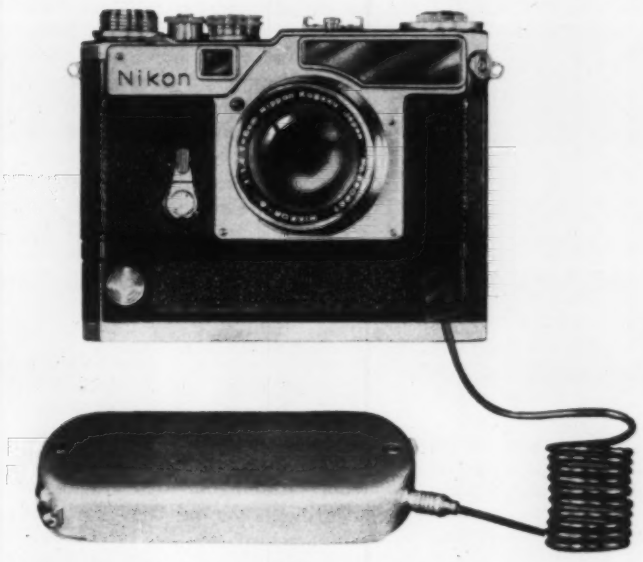


Miniaturization can be seen throughout the photo equipment field. A light burst from Sylvania Electric Products Inc.'s thimble-sized M-25 photoflash bulb provided all necessary illumination for this night photograph (right) of a suburban church. The M-25, while only one-fourth the size of the Press 25 flashbulb, supplies picture lighting equivalent to the larger bulb. Its super light burst is derived through the use of zirconium. For purposes of comparison, two photographs of this suburban church were snapped by the Burns Brothers, a professional photographic team. Illumination for the first (left) was supplied by the church's normal night lighting. A single M-25 was fired for the second.

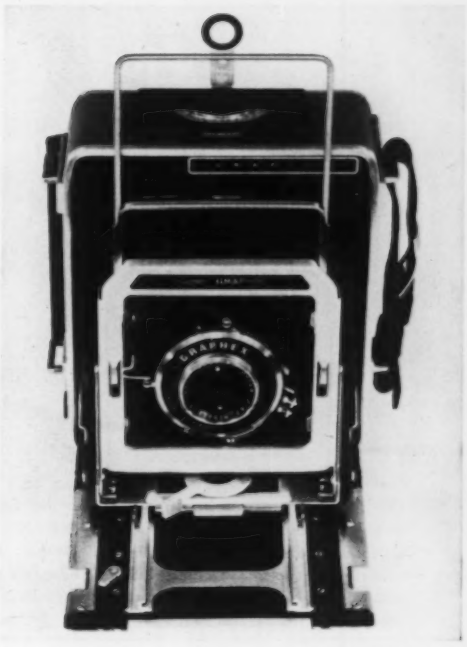
Nonphotographic applications as well as widespread use in 8-mm motion picture projectors are seen for this miniaturized lamp with its built-in reflector. Its sharply focused beam is said to offer advantages in performance, cost, and projector styling. Sylvania Electric Products Inc. predicts the lamp, no larger than a standard flashlight cell, will find uses in fields of automatic controls, infrared heating, and microscopy illumination.

PHOTO

TAKE A CLOSED CARDBOARD BOX, slip a piece of film inside, punch a hole in the front, and control the amount of light that enters. Roughly—very roughly — speaking, you have a camera. Add to this some variations—ultraminiature, 35-mm, 2¼ x 2¼, large-size still cameras, 8 and 16-mm movie cameras, reflex versus rangefinder viewing, interchangeable lenses. Then just for kicks add a few accessories—



Electric motor drives bring new speed and versatility to picture making. The Nikon SP 35-mm camera, shown with its rapid-fire electric-motor drive, can make exposures singly, in bursts of two or more, or continuously through an entire 36-exposure film load. In continuous run, exposures are made at a rate of 3 per sec. The camera can be controlled directly from the camera or remotely from the battery case.



The large camera remains the mainstay for professionals. "How do you redesign the Rolls Royce of the photographic field?" asked the designers behind the new Super-Graphic. A complete study was made of the camera's functions and this information was coordinated with material gathered by Graflex. The result included an extruded aluminum body for minimum weight and an electric trip mechanism for the shutter so that the camera can be triggered either at its side or from the Graflite battery case. A focusing scale and automatic flash calculator are located on top of the camera. Rangefinder cams matched to specific lenses, actuate the focusing scale pointer for accurate calibration.

EQUIPMENT DESIGN—

Its many variations overlay simple design principles. But who wants simple design?

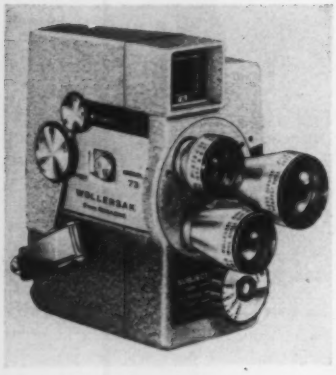
necessary ones of course—flash bulbs or electronic flash units, light meters, filters, viewers, projectors, tripods. Here then is the fertile design field of the photo equipment engineer, with constant change the byword and a yearly U. S. product well in excess of $1 billion.

The U. S. photo equipment designer has his counterparts in England, Germany, Australia, Japan, Switzerland, and other countries, all of whom strive anxiously for their share of the world market. As U. S. camera products find great markets abroad, German, Japanese, and other foreign products pour into this country.

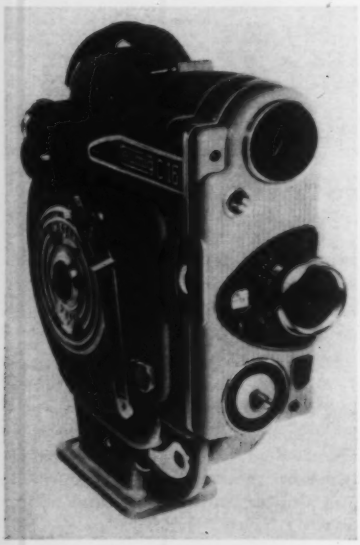
The field abounds with trends. There was the trend to flash, to 35-mm film, to the use of available light, to wide-angle lenses, to long lenses. At the National Photo Show held recently in New York, exhibits pointed up current trends, strikingly similar to trends in other fields of product design. These included simplicity of operation, automatic function, miniaturization of equipment, and the built-in concept.

Simplicity is closely related to automatic function in movie and still cameras, which use a built-in exposure meter to set lens opening and shutter timing, according to the existing light. Bell & Howell, Re-

Foreign camera products play a strong role in U.S. camera purchases. The new underwater housing unit for the Canon camera features large, easy-to-set control knobs for focusing, releasing shutter, setting F-stops and shutter speeds. A special lever gives the photographer his choice of shooting with or without a filter. The housing is but one of the products in the extensive Canon line, said to have won top honors in a Japanese-government sponsored contest to promote originality in design.



Smart styling and ingenious design features are seen throughout the movie camera field. Wollensak-73 8-mm magazine turret camera has built-in filter dial system, so-called "mechanical heartbeat" that permits operator to feel and hear camera transporting film when it operates, and safety position detents that allow camera to operate only when turret is correctly set.

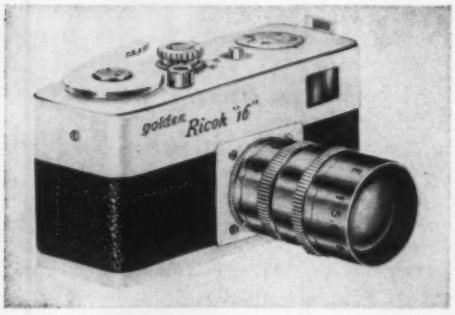


Automatic function and versatility are incorporated in this 16-mm movie camera imported from Austria. Eumig C16's built-in photocell adjusts to all shutter and film speeds to assure correct exposure. It features drop-in spool loading, built-in exposure meter, F:1.9 lens, visible spring wind indicator to prevent overwinding, and automatic parallax correction.

vere, and Eumig are among those making movie cameras just right for box-camera owners; point the camera and press a button. Voigtlander and Agfa are among those featuring automatic or semiautomatic still cameras. Automatic function in still cameras, however, has not penetrated so deeply as in movie cameras, where fewer manual adjustments are required.

Miniaturization of equipment has reduced the size of flash bulbs, reflector lamps, and projector lamps, as exemplified by Sylvania, General Electric, Westinghouse, and Amplex products. In flash bulbs, the use of zirconium for the shredded combustible filling in place of aluminum has resulted in cutting bulbs down to one-quarter of their previous size while retaining all operating characteristics. Not only has miniaturization reduced the size of electronic flash units, but such units as American Speed Light, Mecablitz, and Rectablitz have been transistorized as well.

Ultraminiature cameras are a field unto themselves, made possible by improvements in optics, films, and developers. The quality ultraminiature today is no mere novelty. It has a precisely ground and critically corrected lens, a precision film transport and shutter mechanism, and built-in flash synchronization. Its limitations are movement and dust when taking pictures, dust or scratches during processing.



Place of the subminiature camera today has been compared to the 35-mm camera shortly before it skyrocketed to major acceptance. Ricoh 16 mm is shown here fitted with F:5.6 accessory, 40-mm lens. Basic camera is smaller than a package of cigarettes, has F:3.5 lens, shutter speeds up to 1/200 sec, rapid advance lever, and bright-line viewing window.

The built-in trend is evidenced in the number of box cameras now made integral with flash units. In some of the better movie cameras, filters are turret-mounted internally for positioning between lens and film. Behind-the-lens mounting has the added advantage of preventing filter imperfections from being magnified on the film. Widespread adoption of the built-in exposure meter is of course another example. Drawback to the built-in concept is that, with a greater number of operating components, reliability of the over-all unit may suffer.

The 35-mm field remains the major interest of still-camera amateurs and semiprofessionals. The classic argument here, rangefinder units versus reflex units, may be nearing its solution. Rangefinder units remain easier to focus but present troubles for attachments. Reflex units permit easier use of more lenses, but are not as readily adjusted for pinpoint focus. The trend appears to be in the direction of the single-lens reflex with built-in rangefinder, an example of which is the Alpa 6. Nevertheless, the parallax corrected, bright-reticle unit remains prominent among the top-flight 35-mm cameras. Notable examples are Leica and Nikon.

In color, decamired filters brought out by Tiffen and Enteco replace the customary light - balancing filters, minimizing the number needed for shooting color under all conditions. It appears, however, that filters are destined for less and less use in the color shooting process.

With advances constantly being made in color processing, the trend points away from compensating in the shooting process and toward controlling color balance in the printing process instead. Also, color transparencies may one day be a thing of the past. The move is toward the color negative, which permits either greater color control in the darkroom or inexpensive black-and-white prints made on special paper, such as Eastman's recently announced Panalure.

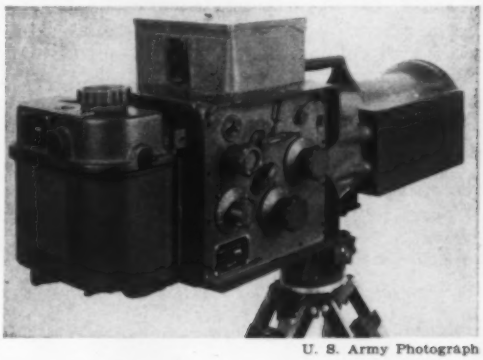
What was a driving demand for larger lenses a year ago has been quieted by the marketing of faster and still-faster films. The introduction of very high-speed black-and-white films by several companies and of high-speed color film, notably Ansco's Super Anscochrome, Tungsten Type, has at least partly satisfied the "available light" photographer.

Special engineering interest attaches to some of the new designs. A black-and-white negative reversing device, made by C. P. Goerz American Optical Co., for example, shows negatives as positives. The company suggests its use for screening huge batches of negatives, in place of making record prints, and for use in clinical studies.

Called the Vertoscope, the device employs a fluorescent screen, an ultraviolet light source, and an infrared light source. Before the negative is inserted, light from the ultraviolet source excites the fluorescent screen, causing it to glow. However, directed light from the infrared source cancels out the glow effect. When the negative is inserted between infrared source and fluorescent screen, dark areas partly block the infrared and permit fluorescence, while light areas permit easy transmission that cancels fluorescence. Thus, black and white areas on the negative are reversed on the fluorescent screen.

Also of special interest is the Praktina electric motor. It attaches to the Praktina FX to convert it to fully automatic film transport for sequence or single-shot remotely controlled photography. Any suitable switch enables the photographer to operate the camera from a distance. When used with a specially designed radio-control unit, the camera can be operated, without wires, at distances up to 1 mile. Suggested applications include automatic counting and measuring procedures, time and motion studies, and nature studies without disturbing wild life. —B. D. Ross

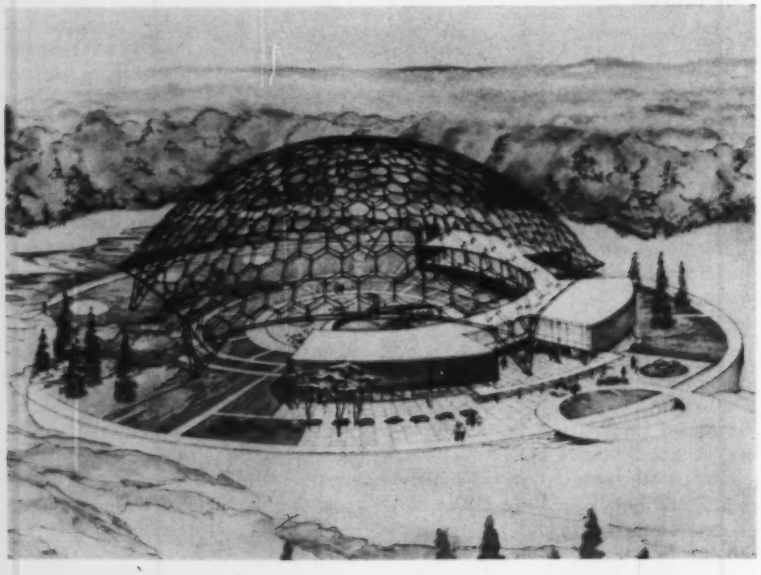
Modern lenses offer the amateur wide scope for his efforts. Particularly versatile is the Bell & Howell Angenieux zoom lens. Excellent for action movies, it can zoom from wide angle—for close shots as shown—to telephoto as the lens "reaches out" to catch the fast-moving action. Other lenses of special interest include the Goerz Tricolor for professional, needle-sharp color separations and elimination of color fringing, and Conemascope lenses suitable for home movie cameras.



U. S. Army Photograph

Big-type zoom, this 100-in. camera is aimed at photographing terrain as far as 30 miles away. Built by the Kalart Co. for the Army, it will operate in the infrared range. Two men are required to focus the camera, one to sight through the built-in telescope while the other adjusts retractable lens barrel.

ANOTHER VTOL VEHICLE being built for the Army is this four-propeller model developed by Fairchild Aircraft. Designed to utilize maximum lift provided by vectored slip stream, the plane is scheduled to fly later this year. Small prop on the tail is needed to provide low-speed control, since the plane lands and takes off with full power on, but with all thrust diverted downward. Other VTOL aircraft under test utilize tiltable wings, swivel-mounted engines, or vertical launching procedures



NEW HOME FOR ASM will include the world's largest geodesic dome. Made of aluminum, the big "space lattice" will be 250 ft in diameter; 103 ft high. Plastic balloons, expandable to the height of an eleven-story building will be used in final erection of the structure. The semicircular headquarters building, is the first step in ASM's long-range building program for developing a complete metal science educational and research facility. Yet to come: Buildings for a metal engineering institute, home study and in-plant training program, metallurgical seminar institute, metals research institute, and a metals science university. Construction of dome and headquarters starts this month on a site 20 miles east of Cleveland.

Federal Space Commission Urged by Engineering Society

Propose Powerful Body Sponsor Space Programs

WASHINGTON—Creation of a Federal Space Exploration Commission with full power to sponsor long-range space programs has been urged by a national engineer's society. The National Society of Professional Engineers has proposed in a policy statement that "the Administration present to the Congress a program for the national direction of space exploration."

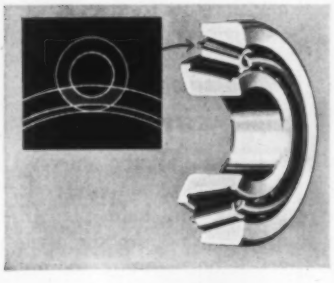
"It is of the utmost importance," the statement said, "that the leadership of the Federal government in the exploration of space not be confined to patchwork or piecemeal attempts to merely co-ordinate the research and development now being carried on by independent military and other groups."

The statement pointed out that "the crucial need of the hour is for the sort of dynamic leadership that will bring about full-scale participation in the responsibilities and benefits of the exploration of space by American industry, by the entire scientific, engineering, military, and educational communities, and by as broad a segment of the general public as possible."

Warning of the "ominous import of the implications in recent Soviet achievements which suggest that the USSR may be widening the gap in heavy rocket engines and specific plans for lunar and planetary exploration," the NSPE statement emphasized that our space programs must be backed by "the full organization and resources of the United States of America."

The statement declared in part that this country "has as great a reservoir of scientific and engineering knowledge and skill as can be found in any nation on earth, but it is clear that America has not accorded the highest priority to the development of projects specifically directed to the furtherance of space rocketry and space exploration." It proposed that the Federal Space Exploration Commissioners be appointed by the President, and that space projects be given legal and organizational status at the highest level of national policy.

Bearings "keep cool" under hot steel!



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ENGINEERING PERSONNEL

LEADERSHIP:

Engineering's Missing Link

LEADERSHIP RANKS as one of the two most important areas for improving engineering productivity. Its effects on productivity are profound and far reaching. It permeates every part of an organization and affects every one of its people. Its partner area of equal importance, planning, has been discussed in a previous article. According to the survey report, *Engineering Manpower: How to Increase Its Productivity**, on which this series of articles is based, leadership's importance is recognized almost unanimously by industry. And yet, survey replies indicate, management as a whole does not fully understand engineering leadership—does not exploit engineering supervisors to their greatest advantage. One consulting firm commented:

- *In our experience, leadership (supervision) is extremely important in achieving sustained output and creativity from engineer-research personnel. Naturally, there is a tremendous range in the caliber of direct supervision encountered. However, it is our belief that for the most part the quality of engineering and research administration and supervision is not as high as it should be and not as high as is usually found in other functional areas in the same company.*

In the appraisal of leadership as it affects engineering, a number of areas were examined: 1. Management-engineer communications. 2. Planning on the supervisory level. 3. Delegating authority and responsibility. 4. Control and evaluation. 5. Unionization as it affects leadership.

*© 1957, G. A. von Peterffy

Management-engineers' communications

Replies to the survey indicate that the supervisor's most vital job is disseminating management's objectives downward and propelling individual engineers' ideas and feeling upward. Without a thorough and understanding exchange of feelings between supervisor and engineer subordinates, every potential benefit of leadership suffers. Yet it was found that management is often oblivious to the need for effective channels of communications with its engineers.

Resolving management's interests with those of the company's engineers is best accomplished through normal supervisory channels. For maximum effectiveness, supervisors must channel information two ways, and this flow must carry both ideas and feelings. In most industrial organizations, and this holds especially true for the large ones, communication is not carried through effectively and its critical effect on motivating engineers is magnified.

It was noted that efforts to improve communication between management and engineering were particularly meaningful to young engineers. The recent engineering graduate is often not in sympathy with management's emphasis on expediency until he becomes aware of the underlying reasons. Too often, however, supervisors do not take the time or the interest to encourage their subordinates to communicate information.

Indeed, it was found that when engineers' ideas or attitudes were made known to a supervisor, he was many times as apt to forget or suppress them as to pass them on to his superiors. This has the two-fold effect of preventing management from responding to the engineers' needs as individuals and depriving management of gains that might result from fully capitalizing on engineers' ideas.

Planning on the supervisory level

Replies to the survey indicate that management depends on supervisors to help plan the engineers' work. As discussed in the article on planning, the upper echelons of company and engineering management generally decide on the policy-making aspects of planning, but supervisors implement the more detailed phases of scheduling and evaluating. Survey answers disclose that, in this area of guidance and control of engineers, a great many supervisors do not maximize their leadership potential. It was found that they do not plan carefully enough to pass on assignments in understandable terms to the engineers who will be respon-

Checkpoints for Engineering Management

- ☑ 1. Are you getting leadership at the supervisory level?
- ☑ 2. Is your company taking the responsibility for training its supervisors in human relations areas?
- ☑ 3. Does your company capitalize on two-way communication . . . from top management to the working levels of the engineering department?
- ☑ 4. Do your supervisors communicate effectively . . . plan work . . . evaluate results?
- ☑ 5. Are you on the alert for technically trained people who would make good supervisors?

sible. Objectives are not specific and the engineers' work is not closely supervised and co-ordinated.

Delegating authority and responsibility

Communication plays a key role in another of the supervisor's tasks: delegating the authority and responsibility of each engineer. It was found that unless authority and responsibility are clearly delegated, engineers work uncertainly and often unproductively with the feeling that management is not concerned about them.

The delegation of authority, particularly in concise terms, is lacking in a surprisingly large number of cases. Most engineering job responsibility in industry, it was found, is left to the resources of the engineer or is defined informally. A management consulting firm outlined this situation and suggested its consequences:

- *In both design and project engineering, many tasks are undertaken on informal authorization or are generated on the initiative of the engineer. While praiseworthy from the viewpoints of alertness and conscientiousness, unlimited exercise of this approach means that the engineers will always be overloaded with tasks generated informally.*

Control and evaluation

The control of engineers and evaluation of their work are also among the primary tasks of supervisors. On the subject of controlling engineers, an engineering council reported:

- *Management's major problem in providing good leadership for engineering-research activities seems to be striking the proper balance between guidance and control on the one hand and providing freedom for the exercise of initiative and creative work on the other.*

With regard to work evaluation, it was found that the supervisor's responsibility is vital to engineering productivity. The survey found that as many as one-half of the engineers in industry may be kept uninformed of their personal progress. The supervisor is the key to this appraisal process. He is closest to the engineer and in the best position to judge his work.

Most supervisors are not, however, taking this responsibility. They are not evaluating job progress day-by-day or constructively criticizing their subordinates' technical work.

Replies to the survey indicate that leadership's objective is to motivate people in definite directions —to get the engineer to produce on his job. It was found that among all the forces a company brings to bear on its engineers, leadership is the most important fact in getting them to do things effectively.

Yet few companies fully exploit their engineer supervisor's potentials. As a group, industry's engineering supervisors were found not to inspire or to know how to "push" their subordinates. Several supervisors, it was observed, did not want to criticize or to explain how a job could be done better because they were, in the words of one, "afraid of offending my engineers." Another would not insist on meeting sched-

uled deadlines because he felt, "It runs the risk of adversely affecting their creativity." These are isolated examples, of course, but they characterize most supervisors' inability to apply pressure to their subordinates in such manner that they turn out the work and do so enthusiastically.

Although management usually recognizes the importance of regarding engineers as professionals, one-third of the engineers contacted do not feel that their companies convey this recognition. Management's inability to get this feeling across was well described by one comment:

> • *First complaint in a "gripe session" is that management wants engineers to think of themselves as part of the management team and display a loyalty toward the employer, but that management does not reciprocate by treating the engineer as part of the team and does not inform him of management policies and decisions.*

It is clear that there are two essentials for maximizing the supervisor's contributions. One is an organizational framework in which he is able to exercise his leadership ability. The second is cultivation of his ability to deal with human problems. Within industry much can be done to improve leadership.

Paradoxically, an engineer is both good and poor material for the molding of a leader. His training has conditioned him to think along orderly lines. On the other hand, this orderly thinking makes it difficult for him to develop in areas that cannot be solved by logic alone—notably, in areas of human relations.

Because engineers in industry are very often promoted to supervisory positions on the basis of technical ability only, the problem is compounded. It is essential, therefore, that management educate supervisors in the art of motivating people, making supervisors appreciate the importance of such things as emotions, attitudes, and prejudices.

Replies to the survey indicate also that management cannot expect the men best suited as potential leaders to express an interest in supervisory work, nor can they expect them necessarily to show their ability. It thus becomes management's duty to encourage this interest.

Unionization as it affects leadership

The unionization of engineers has affected supervision in some companies. Generally, it magnifies poor leadership already existent, and on several occasions, it was found that unions have exploited these weaknesses. In every company where the survey encountered engineering unions in existence, there were some supervisors who would not accept the fact that their engineering subordinates were union members. Because of this, they attempted to take action that by management-union agreement was illegal. In contrast there were others who were afraid to take any action at all or who would attempt to shift responsibility because of unions. Where these conditions exist, effective leadership is often very difficult.

Next article in this series will appear in the April 17 issue. It will discuss engineer's working conditions and equipment as they affect his motivation and productivity.

Recommendations for Management

1. Get the Facts.

The prerequisite of good engineering leadership is the willingness of company executives to concede that leadership and supervision of engineers can be markedly improved. First, management must know how engineering work is assigned, controlled, evaluated, and reviewed, and what administrative policies and procedures are in force in the engineering department and why. Only then, through conferences, discussions, personal appraisals, and scrutiny of reports, can management proceed to evaluation.

2. Evaluate Engineering Leadership.

Evaluate leadership in the engineering department starting with the chief engineer or other official in charge. This man's attitudes and abilities as a leader will invariably be reflected in supervision at the lower levels. Improvements in leadership can be instituted only when he appreciates the need or the value of such changes. Evaluation and subsequent action, therefore, must always be channeled through, never around, the head of the engineering department.

3. Develop Competent Supervisors.

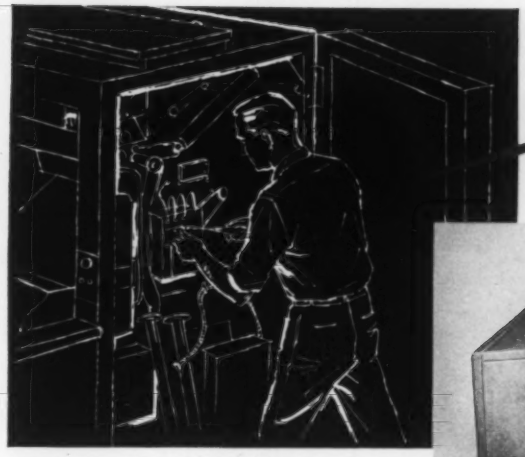
Because engineering leadership appears most deficient and most critical at the lower and intermediate levels, management is advised to develop competent supervisors. This involves developing each supervisor's abilities to deal effectively with others as human beings. The supervisor must impart a sense of drive, a sense of urgency, to the engineers working under his direction. And because engineer subordinates tend to respect most the opinion and judgment of technically competent people, technical ability should be ranked high among criteria for supervisors. But technical competence should not be the sole standard.

4. Give Management's Blessing.

The attitude of higher level engineering management toward supervisory training courses plays an important role in their effectiveness. Management support in the engineering department implements the techniques taught in the classroom. Also, it was noted that every supervisory course cited was conducted by experienced engineering administrators familiar with the requirements and problems of engineering work.

5. Set Procedural Techniques.

In answer to the often heard complaint of lower-level supervisors that they are too busy just getting the work out to bother with leadership and systematic planning, institute such systematic procedures as are appropriate. Aim these not only at improving engineering productivity, but at training the supervisor as well.



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Radio-Control System Regulates Traffic Flow

Programs Traffic Signals According to Conditions

CHICAGO — By transmitting tones, a new radio traffic-control system can regulate the flow of traffic in any way desired. Using the new system, a city can change the programming of its traffic signals to meet rush-hour conditions, changing weather, or other problems in the traffic situation.

It can handle up to 1000 intersections. The system, produced by Motorola, works from a central programmer which may vary from a simple clock device to a complex punched-card or tape system, depending on the number of program changes desired per week.

Information from this programmer is translated into tone codes. These are transmitted by standard radio equipment to FM receivers at each intersection. There, a decoder interprets the tones and sets up the desired change in the local controller.

A central display panel shows the last transmitted program at each intersection and permits manual control of the situation if desired. The receiver and decoder circuits are built with transistors, plated circuits, and sealed units for reliability and minimum maintenance.

Film High-Speed Action With Normal-Speed Camera

Slip-Frequency Technique Gives Slow-Motion Movie

PASADENA, CALIF. — A slow-motion movie of cyclic action can be made with the film running at normal speeds. Basis for the technique is the slip frequency between strobe light flashes and cyclic action.

A new device, called the Camera-Sync and made by Chadwick-Helmuth Co., has been used to record vibration tests results. In application, the subject is illuminated by strobe lights. The Camera-Sync synchronizes the strobe lights with a pulse-type motion picture camera.

When the film is run at normal speeds through a standard projector, the vibration test is shown in slow motion. The picture shown is essentially the same as the slow-motion effect visible under the strobe lights. A quick system, the operator merely "presses the button" to record a test in slow motion.

FAST EXIT from crashed aircraft is possible with this inflatable slide, for use when exits are at dangerous height above ground. A self contained unit with integral inflation system and attachment fittings, the slide can be placed in operation in 20 seconds. If mishap causes deflation, the device can still be used as a fabric sheet slide if held at its base by two persons. The slide was developed by the Air Cruisers Div. of the Garrett Corp.

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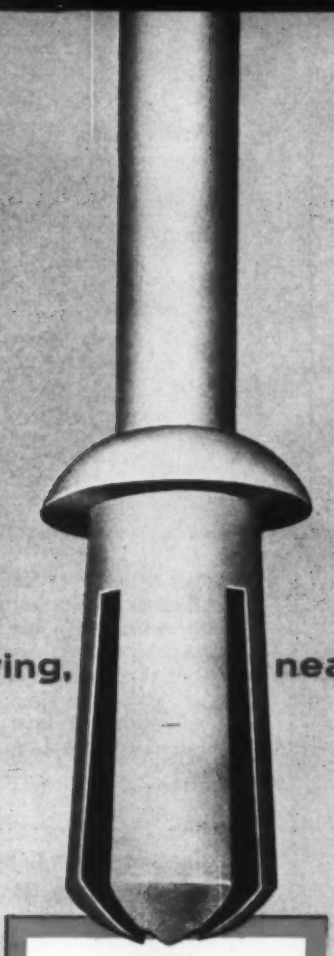
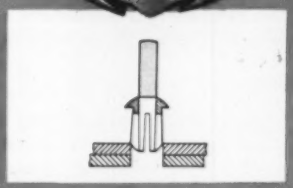
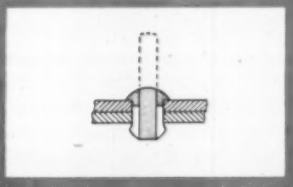




JUST SET . . .



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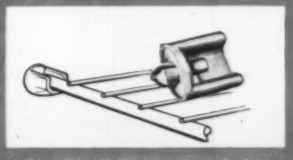
Plasti-Rivets fasten molding onto coin-operated machines, are available in colors to complement product color scheme.



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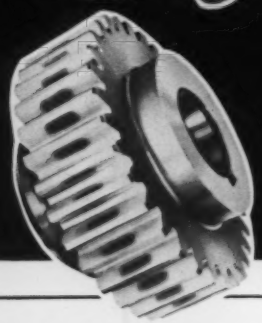

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BULLETPROOF PLASTIC forms the ballistic armor portion of pilot headrests in jet fighter planes. Developed by Garrett Corp., the new, lightweight armor consists of 70 layers of glass-fiber cloth bonded together with polyester resin and press-molded into ½-in. sheet.

Engineering College Research Needs Expansion, More Support

Present Faculties Can Do 10 Per Cent More Work

URBANA, ILL.—More support for fundamental research being conducted in American engineering colleges is called for currently by the American Society for Engineering Education. The society also finds that more research assignments can be accommodated with little change in existing college facilities and faculties.

In a comprehensive survey of the status and needs in American engineering schools, the ASEE finds:

1. Engineering research valued at $100 million a year is now in progress on college campuses.
2. Another $10 million could be accommodated immediately with present staff.
3. The progress of engineering in future years in the U. S. requires a greatly expanded program of basic research today in all technical fields.
4. Increased support of research in educational institutions is vital for the professional development of the faculties, for new knowledge which will result, and for the qualified students it will help train.
5. Budget uncertainties of late

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1957 damaged the "good relationships and the spirit of mutual confidence" which had been built up between the Defense Dept. and educational institutions. Many cuts remain unrestored, and some new programs are still uncertain.

Of the $100 million in engineering research now underway, at least $63 million is financed by contracts and subcontracts with military agencies. At least 7000 individual research projects are currently reported by 110 colleges and universities.

Another survey, performed by the Engineering College Research Council of the ASEE, shows that 6429 engineering faculty members in 108 institutions currently do research the equivalent of 1668-man-years. ECRC estimates 549 additional man-years are available immediately.

In recent statements concerning the surveys, Dr. F. C. Lindvall, president of ASEE, said that the maintenance of healthy financial status and high academic levels in these schools serves two vital purposes:

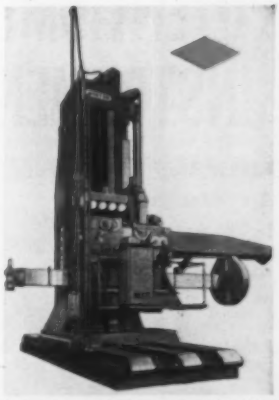
- Increase of basic knowledge to advance the engineering sciences.
- Assure the nation of more well qualified graduates to enter research laboratories and teaching careers.

To realize current research potential in engineering colleges, the ASEE's Committee on the Development of Engineering Faculties recommends a five-point program:

1. Increase the number and amount of basic research contracts with universities.
2. Encourage the participation of graduate students in basic research projects.
3. Make sure that universities are fully compensated for indirect as well as direct costs of research—including the salaries of those faculty members directing projects.
4. Provide federal funds for building or enlarging universities' facilities for fundamental engineering research.
5. Provide long-term basic research contracts with universities, "so that areas of competence may be developed and supported without straining educational resources through contract instability."

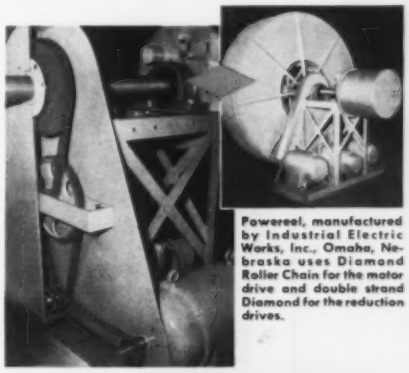
DIAMOND NEWS ABOUT ROLLER CHAIN DRIVES, APPLICATIONS AND NEW PRODUCTS.

From great loads to small precision drives, machinery designers use stock Diamond Roller Chains and Sprockets to save time and money



Morton has replaced counterweight cables on their big 96" Traveling Head Planer with three strand 2½" pitch and two strand 1¼" pitch Diamond Roller Chain due to their superior performance.

Huge 110 ton *Morton* 96-inch horizontal boring, milling, drilling and planing machine uses both three strand 2½" pitch and two strand 1¼" pitch Diamond Roller Chain between counterweights inside the vertical column and the saddle. Earlier machines used counterweight cables, but the satisfaction found in using stock Diamond Roller Chains has made them standard equipment with Morton for this type of service.

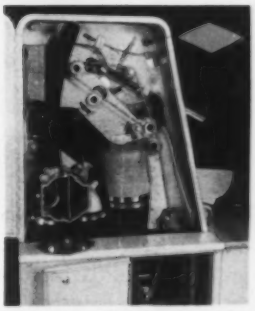


Powereel, manufactured by Industrial Electric Works, Inc., Omaha, Nebraska uses Diamond Roller Chain for the motor drive and double strand Diamond for the reduction drives.

Powereel electric motor driven cable reels, can retract long lengths of cable with constant torque. They are used on gantry cranes, electric tractors, mine donkey cars, overhead cranes and all heavy mobile electrical equipment of this type.

Delivering the power from motors to take-up reel is a job handled by stock Diamond Roller Chain and Sprockets. Their uniform highest quality, long life and 98-99% efficiency deliver *all* the motor power for useful work. Center distances are not critical and thus allow for easy, logical placement of motors and shafts.

P & H Arrow Whiteprinter handles over 97% of all cut sheet work with speed up to 75 feet per minute. Positive driving of many rollers from a single source is accomplished by using stock Diamond Roller Chain. Diamond quality is important here to assure smooth, quiet, dependable, maintenance-free operation.



End view of rollers showing motor and Diamond Roller Chain drive. Note how flexibility of Diamond Roller Chain and sprockets has allowed complete design freedom.

The new Diamond Stock Roller Chain and Sprocket Catalog 757 will help you select stock drives for your applications. Write now for your copy.

DIAMOND CHAIN COMPANY, Inc.

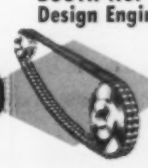
A Subsidiary of American Steel Foundries

Dept. 435, 402 Kentucky Ave., Indianapolis 7, Indiana

Write for new Catalog 757

Offices and Distributors in All Principal Cities

BOOTH NO. 886
Design Engineering Show



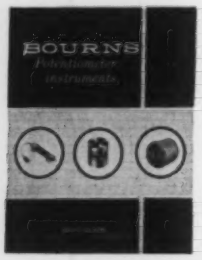
DIAMOND ROLLER CHAINS

Circle 417 on Page 19

New literature on

POTENTIOMETER INSTRUMENTS

Linear Motion • Pressure
Acceleration



1355 proved and tested models

New literature on

TRIMPOT® POTENTIOMETERS

High temperatures • Humidity proof • Special requirements
Wirewound and Carbon
Lug, pin or insulated terminals

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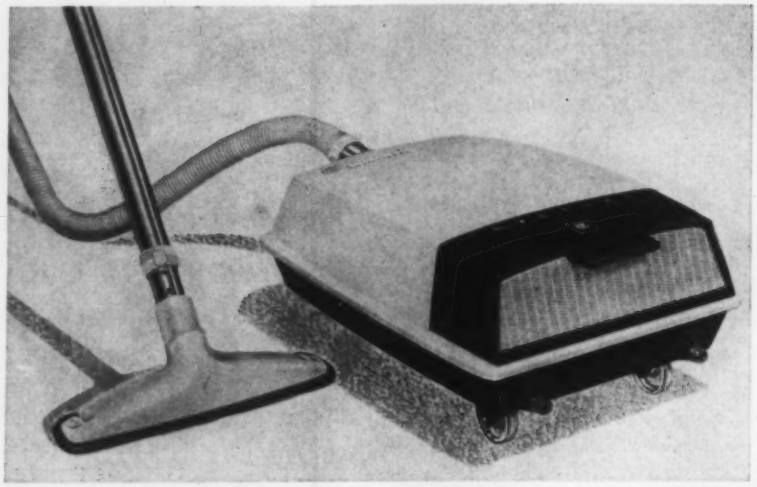
P.O. Box 2112 • Riverside, Calif.

ORIGINATORS OF TRIMPOT®, TRIMIT® AND POTENTIOMETER INSTRUMENTS

Circle 418 on Page 19



SWEEPER STYLING for 1958 parallels the long, low automobile look according to this new RCA Whirlpool model. Lowness permits under-bed clearance; length of the colored aluminum cabinet provides room for a built-in storage compartment that holds five cleaning tools. Sweeper nozzle has a spring-mounted brush that adjusts automatically to carpet pile depth. A rear swivel caster provides manueuverability; cleaner can be tipped on end.

Urges Engineers Develop Nuclear-Powered Turbine

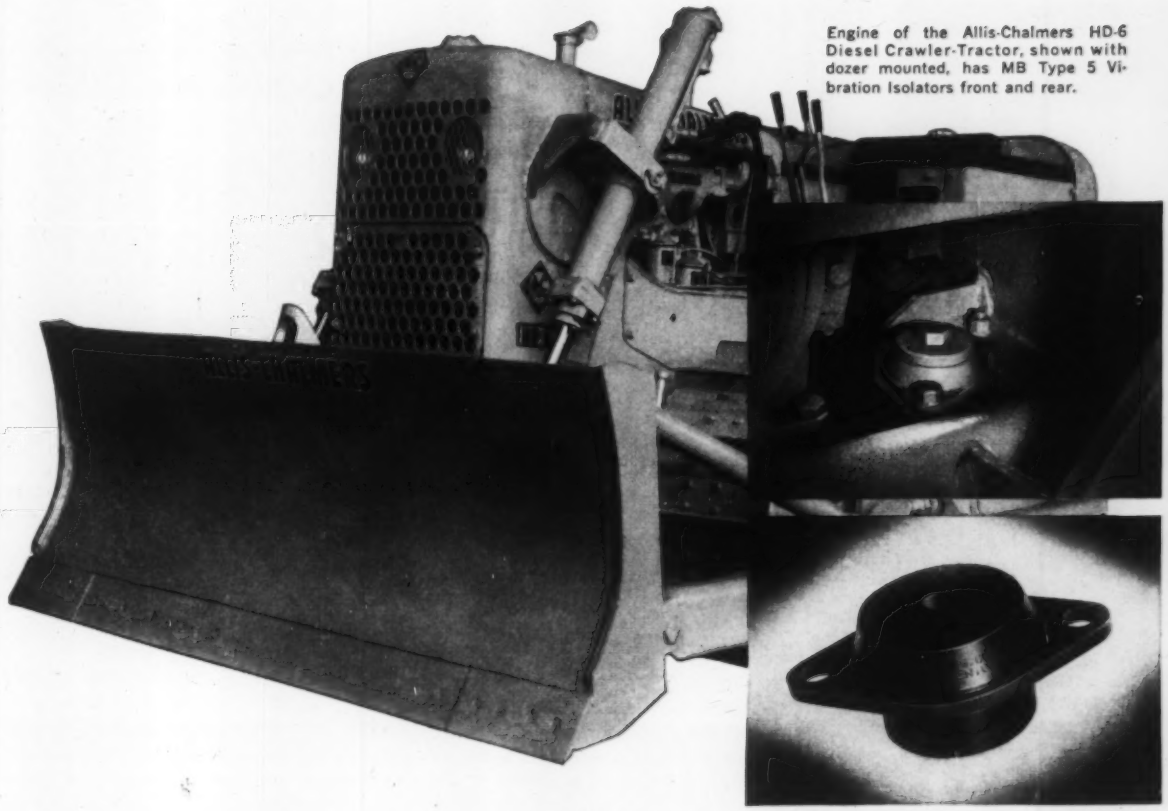
WASHINGTON—Engineers may well strive to combine the nuclear reactor with the gas turbine, despite the vast problems involved, said an official of the Atomic Energy Commission recently. Louis H. Roddis Jr., deputy director of reactor development for the AEC, suggested that gas turbines using a nuclear energy source will ultimately be used in civilian and military power and propulsion plants. He cited current U. S. work to develop nuclear gas turbines to power aircraft.

After pointing out that the U. S. has long been interested in nuclear reactors to power aircraft, Mr. Roddis added that the Aircraft Reactor Experiment, a liquid-salt-fueled and cooled reactor, was operating at Oak Ridge, Tenn., in 1954 with temperature levels which could have permitted gas turbine operation, and an aircraft gas turbine was operating by nuclear power in 1956 at the National Reactor Testing Station in Idaho. He cited among future obstacles the need to operate at high temperatures, which place a strain on turbine parts, and the need for knowledge about many materials that may be useful in such units.

HIGH - BRIGHTNESS GLOW LAMP, claimed to be 20 times as bright as previous models, is intended for use as a pilot lamp on 110-v ac circuits. Developed by GE's Miniature Lamp Div., the new NE-51H indicator lamp has a life in excess of 5000 hr, with an almost constant light output during its entire life. In contrast, GE's previous NE-51 continued to operate long after light output dropped 50 per cent.

Sputnik II is being optically observed by more than 800 astronomical stations in the Soviet Union and by more than 50 in countries in Europe, Asia, and North and South America, according to the Russians. They report the period

MB engine mounts work even in dozer service



Engine of the Allis-Chalmers HD-6 Diesel Crawler-Tractor, shown with dozer mounted, has MB Type 5 Vibration Isolators front and rear.

THE Allis-Chalmers Model HD-6 crawler tractor has the distinction of being one of the first tractor dozers having successful isolation of engine. Many an operator of the dozer can thank use of a main frame and Isomode® Type 5 Mounts for the improvement.

Why is this application so hard on a mount? Obviously, the mount must be capable of surviving severe shock. It has pitching tortuous motions to endure. It is subjected to distortion, to bursts of power and high engine torque.

The MB Type 5 Mount performs to a principle developed by MB specialists over 10 years ago. It has an equal spring rate in all directions, thus equally isolating the six possible modes of vibratory motion. With its core in balanced compression and shear, it offers high load capacity and endurance in compact size; and is safely self-snubbing to control damaging overloads.

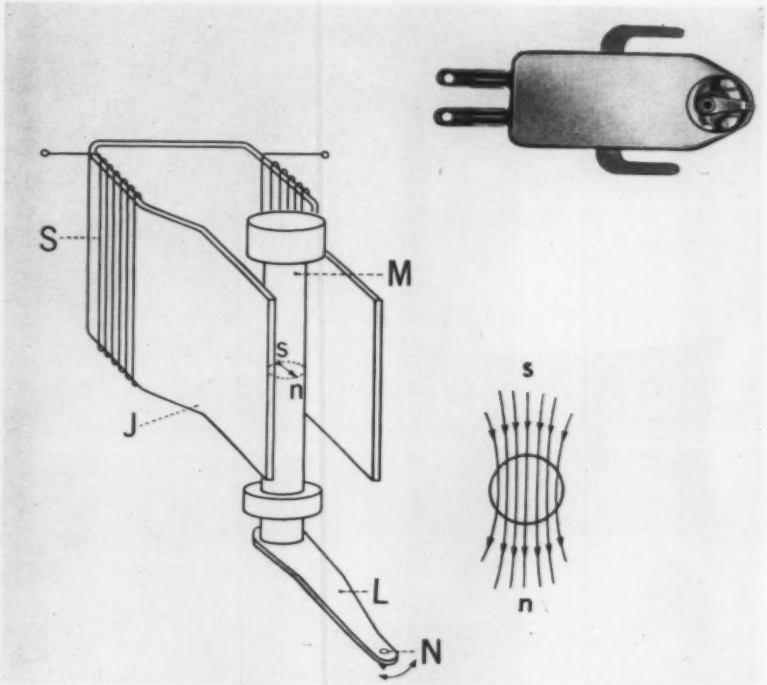
MB concentrates on mounts which start where ordinary units have to give up. While *standard* units are available, MB mounts are actually in the *special performance* class. Perhaps we can work out a modification of one to solve *your* troublesome vibration problem. Send for Bulletin 616A. ® *registered trademark.*

MB manufacturing company
A Division of Textron Inc.
1056 State Street
New Haven 11, Conn.

HEADQUARTERS FOR PRODUCTS TO ISOLATE VIBRATION . . . TO EXCITE IT . . . TO MEASURE IT.

Circle 419 on Page 19

of the revolution of Sputnik II has changed by 6.2 min since its launching. The daily alteration of the period of revolution is now approximately 4.7 sec, compared to approximately 2 sec during its first days of flight. Maximum altitude of the sputnik's orbit above the earth has decreased by 590 km; it is now 1080 km.



Magnetodynamic armature is a thin rod, *M*, 1/32 in. diam and approximately ½ in. long. This armature is magnetized at right angles to its axis (*s-n*) and is rotated about its axis by the transverse vibrations of the cantilever stylus bar, *L*, which is driven by the 1-mil diamond stylus, *N*. The rotation induces a flux in the core, *J*, which generates a corresponding ac voltage in the coil, *S*. Advantages are high compliance, low dynamic mass.

Phono Cartridge Uses Reverse Generator Movement

Nonmetallic Ferrites Permit Magnetodynamic Operation

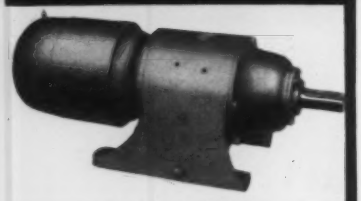
NEW YORK—The first use of nonmetallic ferrites as permanent magnets in phono cartridges permits operation according to the magnetodynamic principle of transducer design. With the magnet in motion and the coil stationary, this is a reversal of the generator movement used in the electrodynamic and variable-reluctance cartridge types.

Heart of the new cartridge is the armature, which is a thin rod made of Ferroxdure, a high-coercivity, hard-ferrite material developed by Philips of the Netherlands. Used in the new Norelco cartridge, the high coercivity and relatively low mass of this material result in a design that combines the ruggedness and high output of the variable-reluctance cartridge and the extreme linearity of the electrodynamic type.

Frequency response is reported to be 10 to 20,000 cps at ± 2 db. The extremely wide and linear response results from the high compliance, which lowers the low-frequency resonance point to well below 10 cps with most pickup arms, and to low moving mass, which raises the high-frequency point well above the audible range, centering at approximately 25,000 cps.

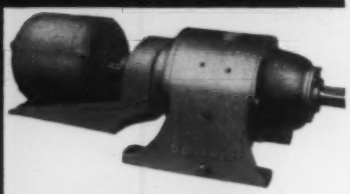
D.O.James
Established 1888

IN-LINE GEARMOTORS



TYPE "MG"
IN-LINE GEARMOTOR—Horizontal or Vertical Drive, 37 sizes, ratio 9.2:1 to 1200:1, 1 to 75 H.P.

IN-LINE MOTOREDUCERS



TYPE "MS"
IN-LINE MOTOREDUCER—Horizontal Drive, 37 sizes, ratio 9.2:1 to 1200:1, 1 to 75 H.P.

OUR 70th YEAR

THESE In-Line D.O.James Gearmotors and Motoreducers are of the same construction and high quality as the individual Gear Speed Reducers which we have been producing for so many years.

They cover a very wide range of ratios, horsepowers, and are an ideal, compact, efficient unit for many power and space-saving installations.

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GEAR MANUFACTURING CO.
1140 W. Monroe Street, Chicago, Illinois
Since 1888
MAKERS OF EVERY TYPE OF GEAR AND GEAR SPEED REDUCER

SEND FOR CATALOGS

Catalogs, price lists and selection tables of gearmotor speed reducers and motoreducers are available to power transmission engineers. Please request on company Letterhead —we'll mail your copy at once.

Circle 420 on Page 19

DESIGN FLEXIBILITY

plus PROVEN PERFORMANCE...

R&M UNIVERSAL MOTORS

foot mounting

end mounting

pad mounting

When you build-in R&M Motors... you build in customer satisfaction

R&M Universal Motors have proven to be dependable performers in hundreds of OEM products used by millions of satisfied customers. You can be sure your product will give more years of reliable, trouble-free operation if it's powered by R&M.

Design engineers prefer R&M Universal Motors for their broad design flexibility. Consider these variables on standard models: AC or DC operation . . . 1/50 to 1/2 hp . . . pad, foot or end mounted . . . rotation in either direction . . . open or totally enclosed. Custom designs with special ratings are also available.

Build customer satisfaction into your next product! Write today for R&M Bulletin 444-MD!

ROBBINS & MYERS, INC.

SPRINGFIELD, OHIO / BRANTFORD, ONTARIO

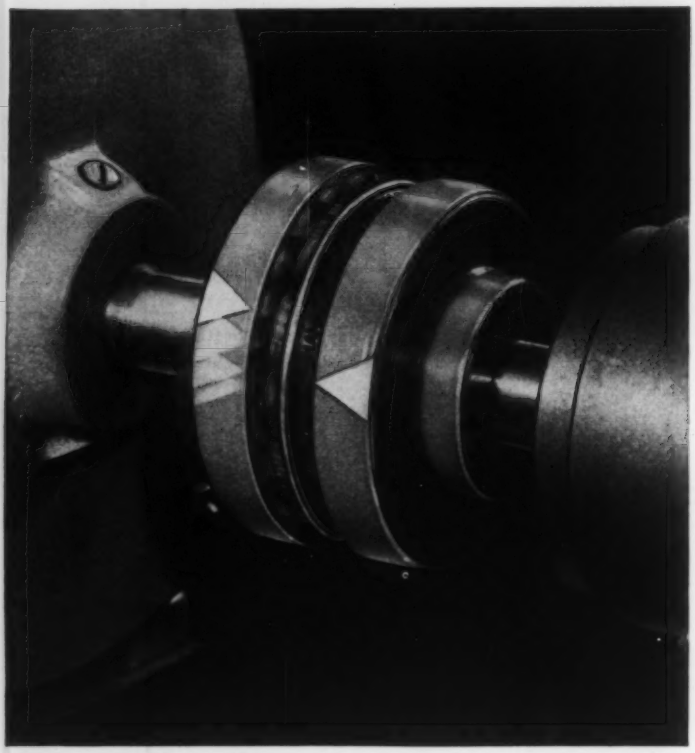
Robbins & Myers build motors from 1/200 to 200 horsepower

Circle 421 on Page 19

NEW SURE-FLEX COUPLINGS

ABSORB 5 TO 15 TIMES MORE SHOCK

BOOST MOTOR AND MACHINE LIFE



Wood's new Sure-Flex Couplings have exceptional torsional flexibility . . . 15° at peak torque as compared to 1° to 3° for other types. They absorb from 5 to 15 times more shock and vibration than other leading flexible couplings, resulting in increased motor and machine life.

Sure-Flex Couplings are simply designed, sturdily constructed and easy to install. There are only 4 basic parts . . . 2 flanges and a 2-piece flexible rubber sleeve. The teeth of the sleeve halves lock into the teeth of the flanges without clamps or screws, tightening securely under torque to provide smooth, dependable power transmission.

Sure-Flex Couplings withstand all types and combinations of misalignment and end-float without wear or high resisting forces. Since all flexing takes place within the rubber sleeve, misalignment will not generate destructive unbalance or pulsations. There is no downtime . . . no need for lubrication or maintenance.

Write for Bulletin 10100. It is filled with helpful application data and additional information about Sure-Flex Couplings.

Wherever You Need Power . . .

. . . Depend Upon Wood's Products To Get It There!

V-BELT DRIVES • VARIABLE SPEED DRIVES • TIMING BELT DRIVES • FLEXIBLE AND RIGID COUPLINGS • FLYWHEELS • PULLEYS • MOTOR BASES • BALL BEARING PILLOW BLOCKS, FLANGE UNITS AND TAKE-UP BEARINGS • BABBITTED AND BRONZE BEARINGS • DUCTILE IRON PRODUCTS

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Wood's

T. B. WOOD'S SONS COMPANY
CHAMBERSBURG, PENNSYLVANIA

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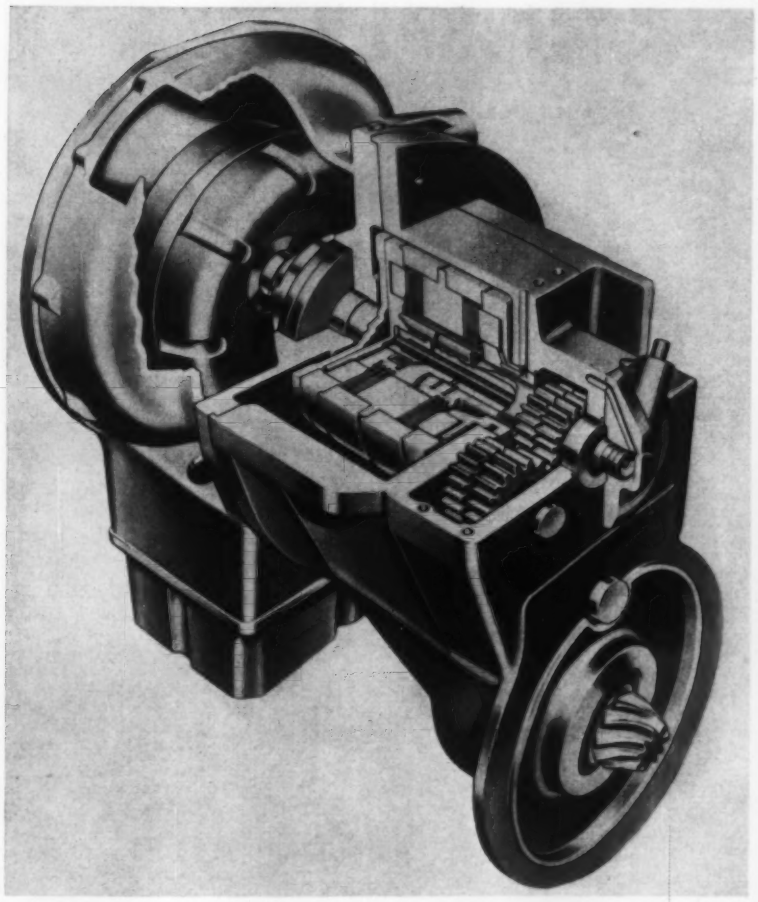

UNLIMITED CRITICAL INCHING is claimed for this power-shift transmission for lift trucks. Key to the new transmission, developed by Hyster Co., is a series of oil-lubricated metal discs which transmit power to the driving gears. The discs are actuated by hydraulic pressure which can be decreased to slow truck movement in crowded areas. This allows the truck to use full lifting speed and "inch" forward in stacking operations. One advantage of this transmission is that it can be shifted from forward to reverse without bringing the truck to a full stop.

AEC Seeks Answer To Fission Byproduct Surplus

Plans Contract to Survey Industry High-Radiation Uses

WASHINGTON—The Atomic Energy Commission plans to award a contract for the evaluation of high-level radiation in industrial operations. The survey is a first step by the Commission to study expected benefits from developing economic high-level radiation for industrial processing.

Successful applications in the food, drug, chemical, plastics, and other industries of high-level radiation sources—such as cobalt 60, fission byproducts, and radiation from specially designed reactors—would be of great importance to the nation's economy.

One aim of the program is to encourage development and application of technology by which the economic value of fission byproducts can be realized in industrial manufacturing processes. With the continued growth of the nuclear power industry in the U. S., ever-increasing quantities of byproducts of atomic fission will be produced.

The contract which the Commission plans to award will have

(*Please turn to Page 44*)

We fabricate in more than 200 different materials*

If it's a problem of the right material for the job—at the right price—Auburn is sure to have the perfect solution among the wide range of materials in which we work.

Put our 87 years experience to work for you—Auburn's engineers are tops in their field in designing and fabricating precision sealing devices. Their know-how is at your command. "O" Rings are a speciality with us.

***Leather • Asbestos • Nylon • Vinyl • Teflon Silicone Rubber • Neoprene • Rubber • Cork Fibre • Compositions • Phenolics • Cloth • Felt Paper • Cardboard • Plastics • Brass • Steel Copper • Aluminum • Kel-F Other Special Materials**

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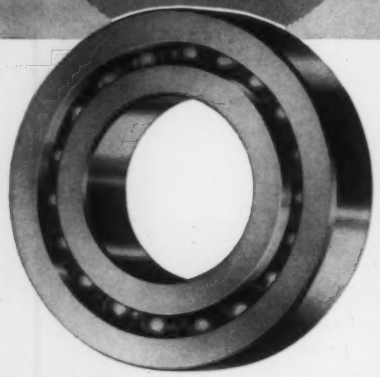
New York, N. Y.; Rochester, N. Y.; Detroit, Mich.; Chicago, Ill.; Minneapolis, Minn.; Pittsburgh, Pa.; Cincinnati, Ohio; Ridgewood, N. J.; Atlanta, Ga.; Memphis, Tenn.; St. Louis, Mo.; Camden, N. J.; Washington, D. C.

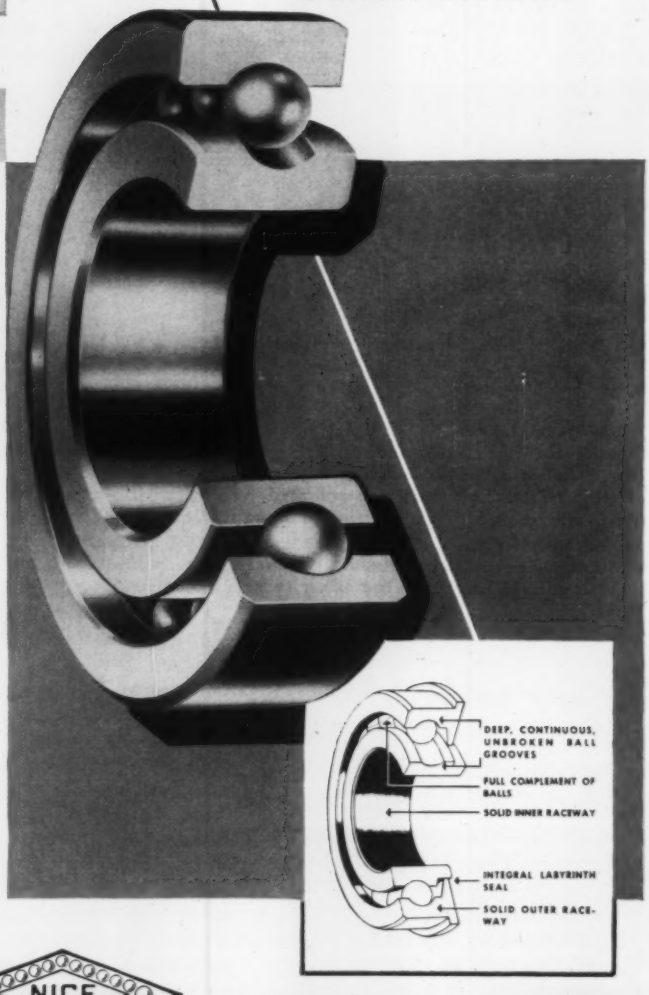
Circle 423 on Page 19

The **NICE** *Way to Lower Cost...*

Premium Performance *at Lower Cost*

with **BALL BEARINGS** *of Revolutionary New Construction!*





NICE now offers the revolutionary new UNIBAL® . . . a low cost ball bearing of superior quality and greater durability, suitable for requirements ranging from the commercial field to many precision applications heretofore using conventional ground bearings. Its simplified construction and assembly method incorporates a new concept in design.* There are no loading slots . . . no split raceways, yet there is a full complement of balls.

Deep, unbroken ball grooves, with closer tolerances and improved finish, provide quiet, smoother operation, with maximum capacity for radial and thrust loads.

UNIBAL Ball Bearings can be furnished in single row, double row, flanged or snap ring types in a wide range of widths and diameters, and the novel construction permits a variety of shield and seal devices.

Your Inquiries Invited.

*Patent Applied For.

NICE®

NICE BALL BEARING COMPANY

NICETOWN · PHILADELPHIA · PENNSYLVANIA

VISIT NICE BOOTH NO. 131, DESIGN ENGINEERING SHOW, CHICAGO, APRIL 14th-17th

Circle 424 on Page 19

...improved performance with **Westinghouse** insulating materials

Proven in over 100 Million Applications
And here's what they can do for you . . .

The Westinghouse line of flexible insulating materials satisfies *every* electrical insulating need. More important, this complete line of flexible insulation, tapes, resins and varnishes has been proven in over *100 million* original equipment applications!

- Silicone glass materials where tough Class "H" heat-resistant products of high dielectric strength are required . . .
- Sturdy, resilient bias-woven tapes where tight bonding over irregular surfaces and contours is necessary . . .
- New Epoxy resin-treated tapes to eliminate wrapping voids, provide a high dielectric strength in the Class "B" temperture range . . .
- Pressure-sensitive silicone glass tapes, where good bonding to metal or itself is required in the Class "H" range . . .
- A host of cambric, paper, asbestos, canvas, glass and combination materials—more than 60 in all—to meet a wide variety of insulating requirements . . .
- And a complete line of quality varnishes and resins meeting rigorous U. S. Navy specifications . . .

In all, there are over 100 different Westinghouse insulating materials that have been *field proven* for your special requirements.

Why not call your nearest Westinghouse office today or fill in the coupon below for complete information. J-06640-A

YOU CAN BE SURE...IF IT'S **Westinghouse**

MD-4-58

Westinghouse Electric Corporation
MICARTA Division, Trafford, Pa.
Plase send me your *Leadership Line Catalog* on Westinghouse insulation, tapes, resins and varnishes.

NAME_____
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COMPANY_____
ADDRESS_____
CITY_____ STATE_____

MANUAL STARTERS

COMPACT... ECONOMICAL COMPLETE LINE

Type "NF" Manual Starters . . . toggle-operated, without overload protection . . . are *compact*, and completely dependable. Rated to 30 Amp., 2 hp capacity at 600 volts. Available in 2, 3 or 4 poles.

Type "RT" Manual Starters . . . push button operated, with overload protection . . . are *small* and reliable. Control single and polyphase motors up to 7½ hp, 600 volts. Available in sizes 0 and 1.

Both "NF" and "RT" types supplied with general purpose, weatherproof or explosion-proof enclosures. Arrow-Hart's complete line also includes manual starters, without overload protection, for reversing and two-speed applications . . . and toggle action switches for other manual starter applications.

Write on company letterhead for 12-page catalog section to The Arrow-Hart & Hegeman Electric Co., Dept. MD, 103 Hawthorn Street, Hartford 6, Connecticut.

ARROW – HART OF HARTFORD

Motor Controls • Wiring Devices • Appliance Switches • Enclosed Switches

Circle 426 on Page 19

ARROW AH HART

ENGINEERING NEWS

(Continued from Page 41)

three phases: 1. Forecast industrial uses of high-level sources of gamma radiation. 2. Survey American organizations to determine current uses for quintalcurie (100,000 curie) and megacurie (1,000,000 curie) gamma irradiators on a commercial scale. 3. Compare technical and economic aspects of high-level radiation with other energy sources, or chemical agents, which may be competitive.

Nuclear energy insurance has been granted to a number of risks, and the formal policy contracts should be ready soon. According to Edward R. Lloyd of the Royal-Globe Insurance Group, "the insurance industry has met the nuclear energy challenge . . . and is . . . in business." He said, "The main objective has been to include indemnification, within reason, against the perils of nuclear reaction, nuclear radiation, and radioactive contamination."

Meetings

AND EXPOSITIONS

April 14-17—

Design Engineering Show to be held at the International Amphitheatre, Chicago. Design Engineering Conference, sponsored by the Machine Design Div. of ASME, will be held in conjunction with the show. Additional information is available from Clapp & Poliak, 341 Madison Ave., New York 17, N. Y.

April 17-18—

Institute of Environmental Engineers. Second Annual Meeting to be held at the New Yorker Hotel, New York. Additional information is available from IEE headquarters, 9 Spring St., Princeton, N. J.

April 20-24—

Scientific Apparatus Makers Association. 40th Annual Meeting to be held at the El Mirador Hotel, Palm Springs, Calif. Additional information is available from association headquarters, 20 N. Wacker Dr., Chicago 6, Ill.

April 21-23—

Metal Powder Association. Fourteenth Annual Meeting and Show, to be held at the Sheraton Hotel, Philadelphia. Further information can be obtained from asssociation headquarters, 130 W. 42nd St., New York 36, N. Y.

April 21-23—

Association of Iron and Steel Engineers. Spring Conference to be held at the Dinkler-Tutwiler Hotel, Birmingham, Ala. Additional information is available from AISE headquarters, 1010 Empire Bldg., Pittsburgh 22, Pa.

April 22-24—

Electronic Components Conference to be held at the Ambassador Hotel, Los Angeles. Further information can be obtained from Mr. David M. Knox, Packard-Bell Electronics Corp., 12333 W. Olym-

pic Blvd., Los Angeles 64, Calif.

April 22-24—

American Society of Lubrication Engineers. Annual Meeting and Exhibit to be held at the Hotel Cleveland, Cleveland. Additional information can be obtained from ASLE headquarters, 84 E. Randolph St., Chicago 1, Ill.

April 24-25—

American Society of Mechanical Engineers-Society for the Advancement of Management. Management Engineering Conference to be held at the Hotel Statler Hilton, New York. Further information is available from ASME headquarters, 29 W. 39th St., New York 18, N. Y.

May 1-8—

American Society of Tool Engineers. Tool Show to be held at Convention Center, Philadelphia. Additional information can be obtained from society headquarters, 10700 Puritan Ave., Detroit 38, Mich.

"I believe they're discussing tolerance."

May 6-9—

Western Joint Computer Conference to be held at the Ambassador Hotel, Los Angeles. Sponsors are American Institute of Electrical Engineers, Association for Computing Machinery, Institute of Radio Engineers, National Joint Computer Committee. Further information is available from Mr. R. E. Utman, Electrodata Div., Burroughs Corp., 460 Sierra Madre Villa, Pasadena, Calif.

May 7-17—

World Trade Fair to be held at the Coliseum, New York. Additional information can be obtained from exposition headquarters, 331 Madison Ave., New York 17, N. Y.

May 12-15—

American Society of Mechanical Engineers. Oil and Gas Power Conference and Exhibit to be held at the Bellevue-Stratford Hotel, Philadelphia. Additional information is available from ASME headquarters, 29 W. 39th St., New York 18, N. Y.

May 14-16—

Society for Experimental Stress Analysis. Spring Meeting to be held at the Hotel Manger, Cleveland. Further information is available from the society, P. O. Box 168, Cambridge 39, Mass.

MOTOR CONTROLS

SMALLEST . . . BY FAR

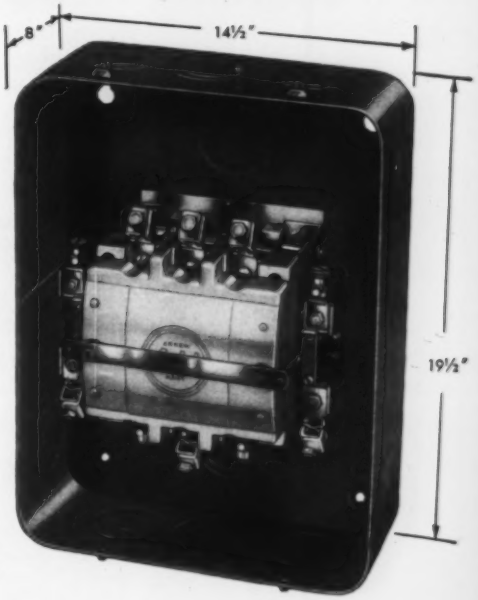
Rugged Size 4 Magnetic Starters

Compact, lightweight Arrow-Hart fully designed Size 4 Magnetic Starter (*smallest size 4 on the market*) provides maximum performance in minimum space. This is made possible by A-H's advanced "RA" (Right Angle) design. Other features add up to dependability . . . *perfect guided alignment* for positive, uniform contacting . . . a *straight thru wiring* that simplifies circuit design, installation and servicing . . . *sturdy contacts* with silver alloy tips. Sizes 0 through 5 Magnetic Starters offer comparable advantages.

Write on company letterhead for 8-page folder on Size 4 Starter and other engineering data on Sizes 0 through 5 to The Arrow-Hart & Hegeman Electric Company, Dept. MD, 103 Hawthorn Street, Hartford 6, Connecticut.

TYPE "RA"

Weight 56¼ lbs.



ARROW – HART OF HARTFORD

Motor Controls • Wiring Devices • Appliance Switches • Enclosed Switches

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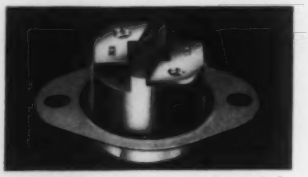
in

JOHN ZINK

JZ

Gas Heaters...



KLIXON 202 Series fixed temperature control.

KLIXON

SNAP-ACTING CONTROLS help hold field service to less than 1%

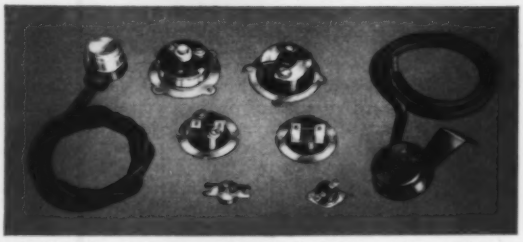
"We've specified and used KLIXON *snap-acting thermostats for several years and our field service has been held to less than 1%."*

That's how the John Zink Company of Tulsa, Oklahoma, manufacturers of this Gas Fired Forced Air High Boy Heater, feels about KLIXON Snap-Acting Controls.

The Zink Company is another of the many manufacturers who have maintained trouble-free, dependable service by using KLIXON controls. You, too, can benefit yourself and your customers by using these simple, snap-acting controls — available in many hermetically sealed and open types in a wide variety of operating temperature ranges.

Write today for catalog THSN — it gives full details on the KLIXON temperature control line.

John Zink Gas Fired Forced Air High Boy Heater.



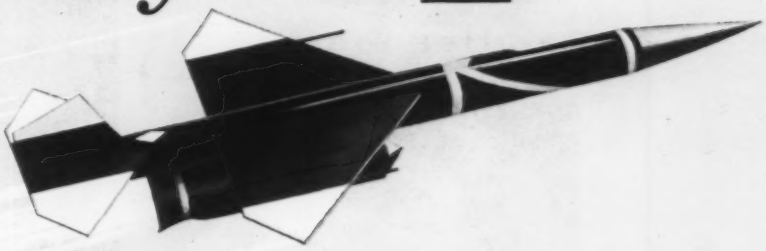
Typical KLIXON Fixed Temperature Controls for many types of home appliances.

METALS & CONTROLS CORPORATION

Spencer Division 3204 Forest Street, Attleboro, Mass.

KLIXON

Cleanliness ON THE GROUND *is Reliability* IN THE AIR!

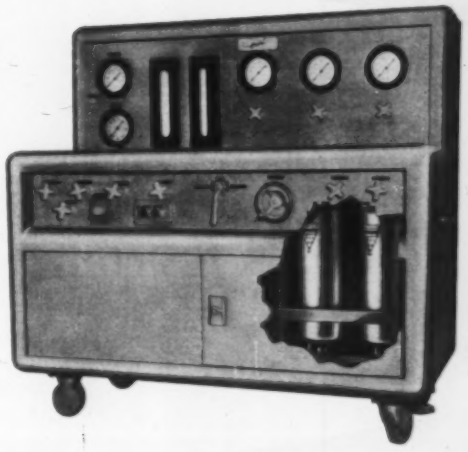


Are you Getting 2-Micron Filtration?

With the installation of **ENGINE LIFE MICRONETIC FILTERS** and the employment of proper filtration technique, you can be assured of contamination removal down to .30 milligrams per 100 cc of fluid. This has been proved by one of our major missile manufacturers, both quantitatively and qualitatively. **ENGINE LIFE PRODUCTS CORPORATION** designs, manufactures, and engineers standard filtration equipment, as well as many highly specialized applications.

ENGINE LIFE FILTERS are specified equipment on this "Hydraulic Power Supply Unit" for flushing and pre-flight in high performance hydraulic applications. Manufactured by Coleman Engineering Company, Inc., Torrance, California.

Cut-away section shows **ENGINE LIFE FILTERS**, original equipment on this "Missile Component Hydraulic Check-Out Stand" manufactured by Haskel Engineering & Supply Co., Glendale, California.



Specified by Leading Manufacturers of Missile and Aero Test Stand Equipment

Get the facts about the solution of your **FILTRATION** problems with standard or custom-designed **ENGINE LIFE FILTERS.** MAIL COUPON NOW!

ENGINE LIFE PRODUCTS CORPORATION *FILTERS FOR THE LIFE OF YOUR ENGINE*

EL MONTE, CALIFORNIA

INDUSTRIAL · AUTOMOTIVE · AIRCRAFT · MARINE · AGRICULTURAL

Limited Number of Distributorships Available — Write, Wire or Phone

Circle 429 on Page 19

ENGINE LIFE PRODUCTS CORPORATION El Monte, Calif.

Please send me information on FILTRATION for the industry checked below:

☐ MARINE ☐ AIRCRAFT ☐ INDUSTRIAL
☐ AUTOMOTIVE AND TRUCK ☐ AGRICULTURE ☐ CONSTRUCTION

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COMPANY_____

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For the control valve on your drawing board

...see HANNIFIN

Need a custom-built control valve for your prototype or your production? If foreseeable quantities are substantial, the exact valve you need may be available at an unforeseen saving—if you bring your specifications to Hannifin.

Hannifin will design these special control valves to mesh with your designs and bring your dream machine of tomorrow into reality.

These valves will look new, and they will do the new work which you are planning. But they will also be Hannifin valves—trustworthy products of Hannifin engineering and manufacturing skills.

See your Hannifin man and tell him about your new kind of machine for which a new kind of valve is needed.

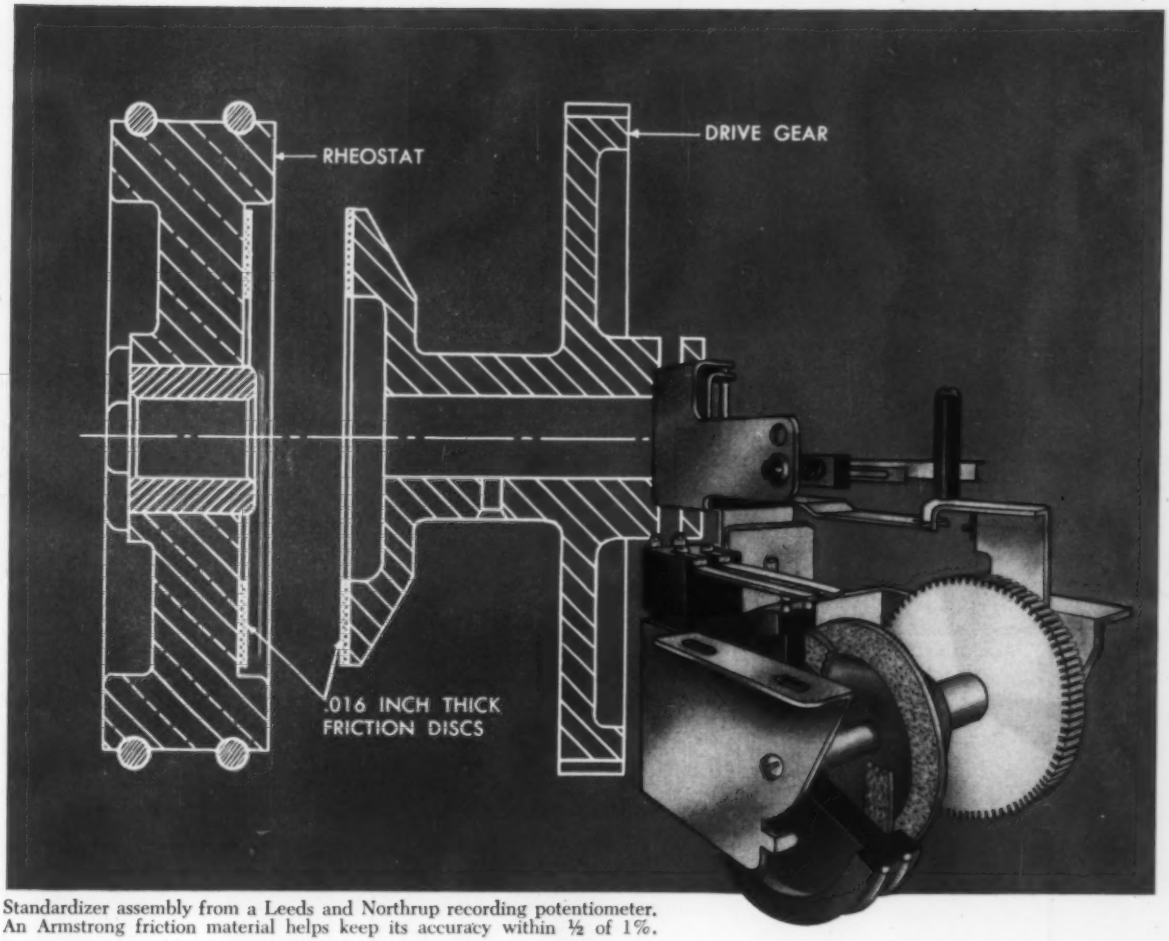
AIR AND HYDRAULIC

HANNIFIN

CONTROL VALVES

Write for Hannifin's complete Control Valves Catalog. If the special valve you need is an air valve, it may already be a standard item in the Hannifin line. Hannifin Company, 515 South Wolf Road, Des Plaines, Illinois. (Hannifin Company is a division of Parker-Hannifin Corporation.)

Circle 430 on Page 19



Standardizer assembly from a Leeds and Northrup recording potentiometer. An Armstrong friction material helps keep its accuracy within ½ of 1%.

Armstrong clutch facing offers positive engagement at low pressures to improve instrument accuracy

The accuracy of potentiometer-type industrial recording and control instruments depends on an unvarying input current derived from dry cells. This input is kept constant by a standardizing mechanism like the one shown above.

A rheostat is used to compensate for declining battery voltage. The rheostat is adjusted at regular intervals by a friction-faced drive gear, which engages against another friction facing on the rheostat. The unit is designed to be accurate within ½ of 1%, and an Armstrong friction material helps keep accuracy well within that limit.

The material is Armstrong NC-733, a cork-rubber facing. It engages instantly and positively, even though closing pressure is limited to 28 ounces. On disengagement, it breaks away cleanly without random motion that could destroy the accuracy of the adjustment.

When the rheostat reaches the end of its travel, the friction material must slip for short periods to avoid damaging the mechanism. Tests on NC-733 showed no wear as a result of this slippage so neither part ever needs to be replaced.

Whatever combination of requirements your application demands, chances are there's an Armstrong resilient facing to fit the job. Talk it over with your Armstrong man next time he calls.

SEND FOR INFORMATIVE BOOKLET

A new booklet, "Armstrong Resilient Friction Materials," has just been published. It gives valuable information on how to use resilient facings most efficiently. To get your copy, write to Armstrong Cork Company, Industrial Division, 7204 Dean Street, Lancaster, Pennsylvania.

Armstrong RESILIENT FRICTION MATERIALS

. . . used wherever performance counts

University

produces a powerful but very compact soundcaster by using

DIE CASTING

CASE HISTORIES FROM MT. VERNON FILES

In this model PP-2 Pistolgrip "Powrpage," University has embodied the most advanced features of any electric sound-casting system. Aim, press, talk—it projects clear, powerful sound in any direction. A mighty voice for such a compact, light weight unit, only 4½ pounds including batteries. The Pistolgrip with microphone built into the horn base permits ready, one hand use. 6 pencil batteries are all held in the slim handle which also contains the "Powrsaver" press-to-talk switches and—the entire unit is *weatherproof* throughout.

How was such compact design achieved . . . by resorting to die casting which gives thin, rigid sections of great strength.

How was weight brought down to 4½ pounds . . . by die casting three main parts in aluminum.

How was cost held down to lowest figures possible . . . by utilizing all the inherent advantages of die casting to make the intricate shapes economically. The two-casting handle houses microphone, driver unit and power supply and the tone arm combines an outer shell with four spacer arms and an inner sound director core into one unit.

How was it made so weatherproof . . . because die castings can be held to extremely tight tolerances.

You too can realize the many advantages of die casting by using the complete service available from Mt. Vernon's coordinated designing, die-making, casting and machining facilities all under one roof, which can supply die cast zinc and aluminum parts ready for use. Contact your nearest Mt. Vernon sales representative for action.

MT. VERNON
DIE CASTING CORP.
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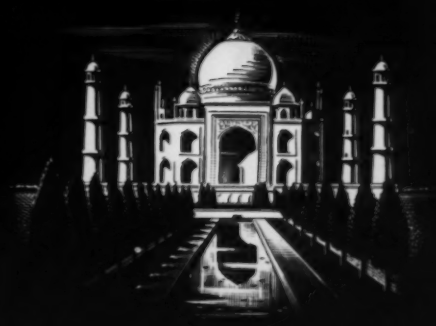
No matter where your customers buy Macoma



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Shell Dromus Oils—soluble cutting oils for high-production metal working

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Its performance and name are the same around the world

Shell Macoma Oils are premium quality, fortified extreme pressure gear oils. They provide superior high-load-carrying capacity and are particularly effective where overloading, severe shock-loading or general heavy-duty conditions exist.

Macoma* Oils have these added built-in benefits: excellent resistance to oxidation, great adhesiveness, rapid separation from water. They are non-corrosive, non-foaming and have high stability in storage.

The world-wide availability of Macoma Oils is assurance that your customers abroad will get the same performance from your equipment that your domestic customers rely upon. For complete specifications, write Shell Oil Company, 50 West 50th St., New York 20, N. Y. or 100 Bush St., San Francisco 6, California.

*Registered Trademark

SHELL MACOMA OIL

SHELL

Circle 433 on Page 19

Count on *Continental* to

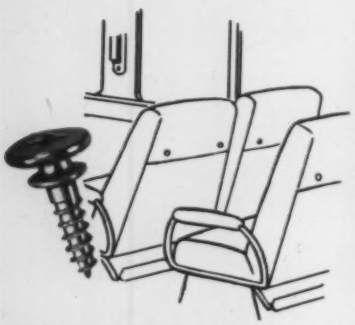
meet special fastening problems

with specialized cost-saving experience

Continental Assembly Engineers' Specialized approach to fastener trouble-shooting assignments gets you the right answer promptly, with the biggest cost savings — for two reasons.

First, since Continental can supply more types of standard fasteners, from stock, their recommendations are unbiased. They can tell you if some "standard" you've overlooked will meet your needs.

Second, if a "special" is the best answer, you can rely on Continental's unlimited experience to design and produce a fastener that will meet all specifications at the lowest possible cost.

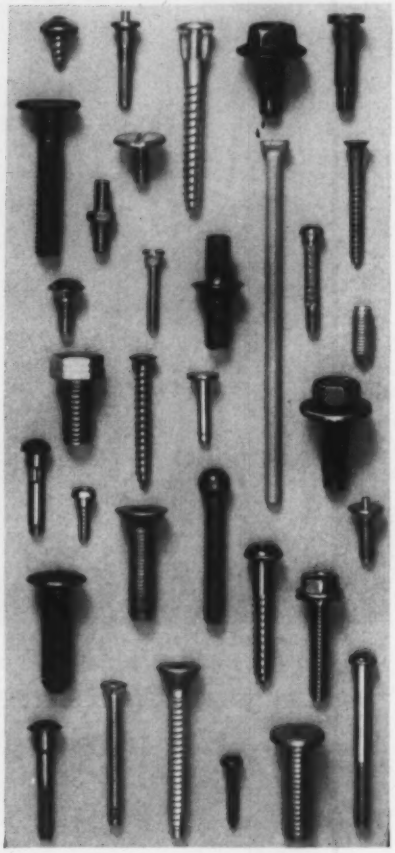


SPECIAL HOLTITE® PHILLIPS
button-head screw replaces two-piece fastening . . .

A bus builder asked Continental Assembly Specialists how to simplify installation of towel-holding buttons on back of bus seats. Separate wood screw and metal button being used caused slow work, with many pieces dropped and wasted.

One-piece button head special screw designed by Continental reduced parts cost 10%. Easy installation of simplified fastener provides much bigger saving in assembly costs.

COST LESS
SPEED ASSEMBLY



HOLTITE® NYLOK®
self-locking screws solve problem of screws loosening in chain saw

When consulted by a chain saw maker on the problem of screws vibrating out, Continental Assembly Specialists had the answer in HOLTITE® NYLOK. Two of the several types of machine screws furnished, all fitted with the resilient nylon plug, are illustrated. These NYLOK screws do not loosen in spite of extreme vibration, keep the saws "on-the-job". Previous customer complaints of high maintenance costs were eliminated.

END COMPLAINTS OF
HIGH MAINTENANCE COSTS

"Special" attention like this will pay off for you . . .

It costs you nothing to talk to a Continental Assembly Specialist. And, as soon as he digs into your problem, you'll see what we mean by "specialized experience". For prompt service, write or phone: Continental Screw Co., 461 Mt. Pleasant St., New Bedford, Mass.

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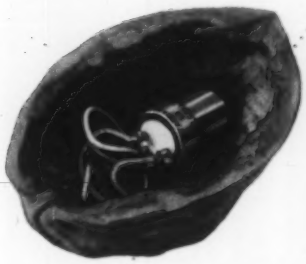
CONTINENTAL
HOLTITE FASTENERS

HOLTITE PHILLIPS AND SLOTTED HEAD
WOOD • MACHINE • TAPPING • THREAD CUTTING • SEMS • NYLOK
HY-PRO PHILLIPS INSERT BITS AND HOLDERS

Circle 434 on Page 19

miniaturization in a nutshell



STATHAM MODEL P222 flush diaphragm pressure transducers... for the measurement of absolute, gage, or differential pressures.*
DIMENSIONS: .25" diam. x .47" long
WEIGHT: 3 grams, approx.
RANGES: 0-10 to 0-200 psia, psig, or psid; ±5 to ±25 psid.
NON-LINEARITY & HYSTERESIS: Not more than ±1% fs
TRANSDUCTION: Resistive, complete bridge; Statham unbonded strain gage

STATHAM MODEL A52 linear accelerometer...*
DIMENSIONS: .32" wide x .35" high x .84" long
WEIGHT: 8 grams, approx.
RANGES: ±5 to ±100 g
NON-LINEARITY & HYSTERESIS: Not more than ±1% fs
TRANSDUCTION: Resistive, complete, balanced bridge; Statham unbonded strain gage

Statham's line of miniature transducers for the measurement of pressure and acceleration are constructed to give accurate, reliable service in applications which demand critical space requirements. These rugged, laboratory-calibrated instruments are especially suitable for use in the supersonic aircraft and missile fields.
If there are critical space problems in your instrumentation program, the requirement for accuracy and reliability need not be sacrificed...when you specify Statham. Our application engineers are always ready to help with your instrumentation problems.

*Model shown actual size. Complete technical data are available upon request.

Statham INSTRUMENTS, INC.

12401 W. Olympic Blvd., Los Angeles 64, California

Circle 435 on Page 19

Circle 436 on Page 19→

Get better protection...more reliable

...WITH GENERAL ELECTRIC

operation for your product

TRI 55 CLAD ENCLOSED MOTORS

HERE'S WHY:

External Features: Moisture-resistant sealing compound is applied on carefully machined rabbets to assure better protection against moisture and dust. Corrosion-resistant, non-sparking fan on all enclosed fan-cooled Tri/Clad '55' motors resists action of the strongest acids and alkalis. Jet action cools motor effectively and efficiently for long-life operation.

Lead connections are protected from contact with moisture and dirt by a cork-neoprene gasket between halves of the easy-access conduit box.

Further, a new lead positioner gasket between conduit box and frame is impervious to cutting fluids—protects internal parts effectively.

Internal Features: Mylar* polyester film insulation and Formex† magnet wire provide greater moisture and heat-aging protection. Water-resistant stator coating also guards against failure due to moisture. And G.E.'s advanced bearing system gives years more service.

General Electric offers you the most complete line of enclosed motors in the industry, including standard enclosed, severe-duty (for highly corrosive atmospheres), and explosion-proof motors.

CONTACT your nearest G-E Apparatus Sales Office now for *personal proof* on why G-E Tri/Clad '55' enclosed motors can do a better job for your applications. And ask for a free copy of these descriptive motor bulletins: 1-5 hp—GEA-6240, GEA-5980, and GEA-6341; 7½-125 hp—GEA-6602. Or write for them to Section 840-20, General Electric Co., Schenectady 5, New York.

*Registered Trade-mark of DuPont Co.

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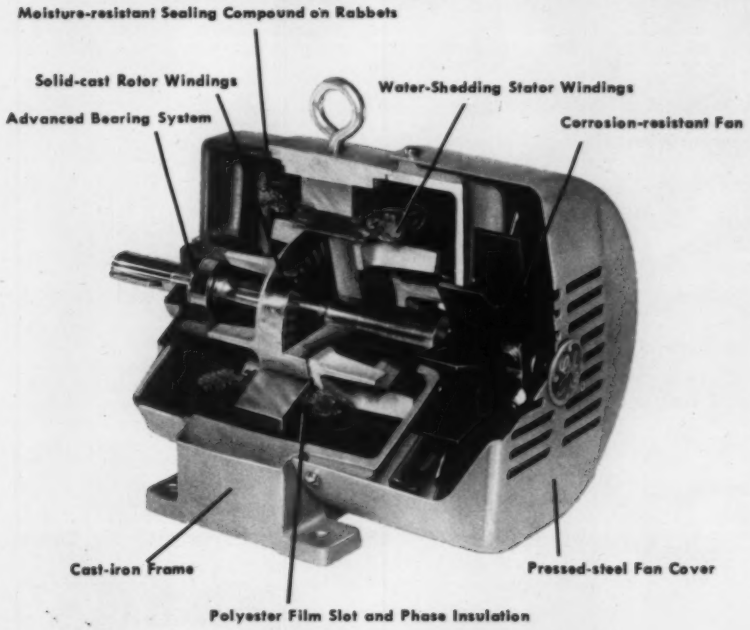
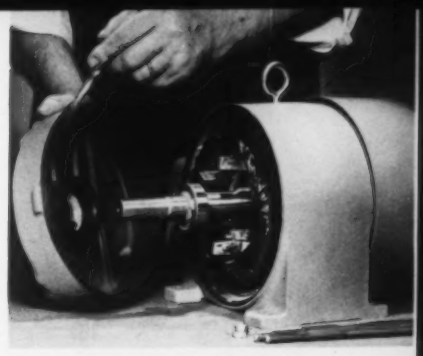
GENERAL ELECTRIC

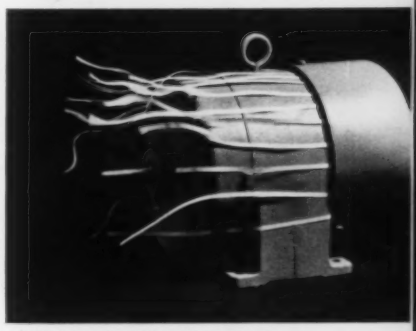
COMPARE THESE TRI 55 CLAD FEATURES



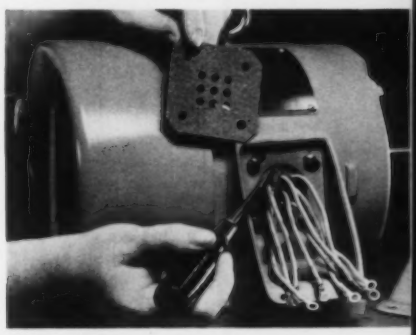
Standard enclosed Tri/Clad '55' motor



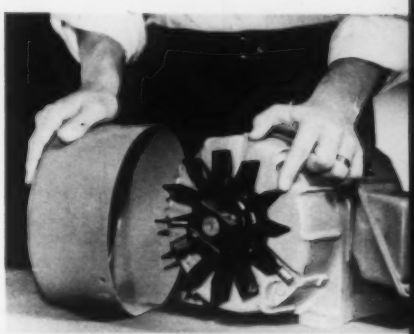
Water-resistant Rabbets protect against moisture, dirt, and abrasive dust for longer life.



Efficient Jet Cooling System spreads a smooth blanket of air over the entire motor frame.



New Lead Positioner and gasket saves connection time; is impervious to cutting liquids.



Non-sparking Fan effectively cools the motor—resists action of strongest acids and alkalis.

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April 14-17

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Again this year . . . the editors of MACHINE DESIGN will be on hand at the Design Engineering Show, Booth 112 to talk over your design plans and problems.

Or, if you would like to discuss a particular topic that has already appeared in MACHINE DESIGN—come in anytime during show hours.

We'll be looking forward to seeing you.

Remember Booth 112 ▶ where engineers, problems and editors meet.

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See our Exhibit in BOOTH 768 at the Design Engineering Show

VICKERS® New ¼" Temperature and Pressure Compensated FLOW CONTROL VALVE

ANOTHER VICKERS FIRST

FOR OPERATING PRESSURES UP TO 2000 psi

For years the Machine Tool Industry has been asking for a combination Temperature and Pressure Compensated Flow Control Valve to insure CONSTANT FEED RATES. Now for the first time it is available as a production unit at a reasonable price.

Check THESE EXCLUSIVE FEATURES that mean Optimum Tool Life and Better Work Finish:

- **TEMPERATURE COMPENSATED** — Constant feed rates all day long with same throttle setting because throttle automatically compensates for changes in oil temperature. The compensator mechanism is simple in design and durable.
- **PRESSURE COMPENSATED** — Constant feed rate throughout entire cycle because built-in pressure hydrostat automatically compensates for load changes.
- **SINGLE THROTTLE COMPLETE RANGE ADJUSTMENT** — Greater flexibility because valve is adjustable within entire flow range of 5 to 1000 cubic inches per minute.
- **REVERSE FREE FLOW AS STANDARD FEATURE** — A standard feature which permits reverse free flow (up to 1400 cu. in. per min.) from outlet to inlet port by-passing control elements.
- **TAMPER-PROOF ADJUSTMENT** — Retension of original feed rate is assured because a set screw prevents inadvertent throttle movement and a cover over the set screw can be locked in place.
- **INTERCHANGEABLE** — This new valve replaces 12 previous models and it is interchangeable with all of them, also the drain connection is eliminated on the new valve to simplify piping.
- **GREATER ECONOMY** — No need to stock several valves for wide range of flow rates. Drain connection is eliminated, piping costs are reduced.
- **MAXIMUM RELIABILITY AND ACCURACY** — Design of temperature and pressure control components assures maximum circuit reliability and extreme accuracy of feed through a range of 5 to 1000 cubic inches per minute.

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ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921

Circle 438 on Page 19

BAKELITE Brand PHENOLICS ... Specify these fine quality materials when your design needs outstanding electrical properties . . . superior heat resistance . . . rugged strength . . . ease of fabrication . . . economical cost.

There's a wide selection of these phenolics, including the latest BAKELITE Brand BMM-7000. This outstanding molding material offers fast cure, higher gloss and excellent electrical properties. Pastel color effects on phenolics may easily be obtained by using coatings based on BAKELITE Brand Epoxy Resins. See how this superior molding material can help to improve your product design. Write for technical literature.

BAKELITE PLASTICS . . . *do so much*—so much better!
BRAND

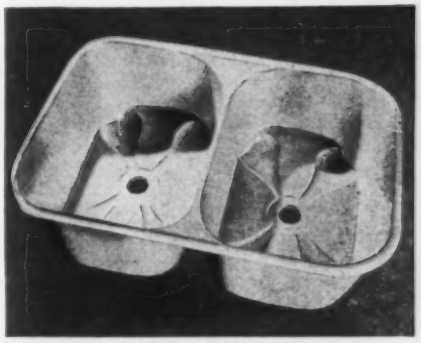
WITH BAKELITE BRAND PLASTICS

Join other designers who use these materials to achieve better products at lower cost

Better products at *lower* cost is the best way to beat the profit squeeze. These applications are only typical of the countless opportunities available to you with BAKELITE Brand Plastics. Whether yours is a consumer, industrial or a military design problem, you have a wide selection of plastics of the highest quality—plastics with an exciting range of properties—at the most attractive price scale ever.

So—don't make a design decision until you have explored the proven advantages of BAKELITE Brand Plastics and Resins—advantages that can in many cases offer you color, shape and finish in one fast operation. Write Dept. MD-48 for technical literature, today.

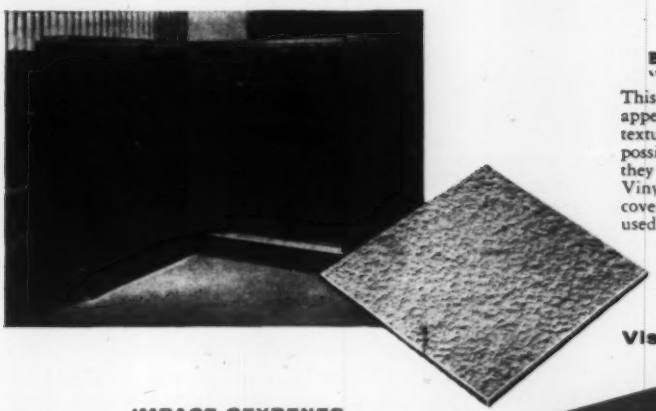
BAKELITE COMPANY WILL HELP YOU. Technical representatives—who combine years of intensive training and field experience are available to discuss your special design problems. Their recommendations are backed by one of the largest plastic research laboratories in the world.



BAKELITE Brand STYRENE...2 sinks from 1 sheet...in 1 fast operation

Patented dual sink insert converts a kitchen sink into a double sink. It is vacuum formed from a styrene sheet made from BAKELITE Brand TMD-2155. BAKELITE Brand Styrene was chosen after other plastics tested failed to give the "deep-draw" characteristic required. TMD-2155 is lightweight yet assures high impact strength. It is available in a wide range of colors that resist hot, soapy water. Other types of BAKELITE Brand Styrenes offer excellent design properties for refrigerator door liners, sight glasses, beverage servers, battery cases and more. WRITE FOR TECHNICAL LITERATURE.

Styrene sheeting extruded by Jet Specialty Plastics Company, Inc., Los Angeles, California.



BAKELITE Brand VINYL RESIN is used to make "paint that looks like leather and wears like iron"

This patented "Armorhide®" coating protects and enhances the appearance of world-renowned IBM computers with an attractive, textured, scuff-resistant finish. Discover the coating excellence possible with the variety of BAKELITE Brand Vinyls. See how they can work for better products at better costs. BAKELITE Brand Vinyls have improved the design of upholstery cushioning and coverings, chemical and corrosion-resistant paints and coatings used on storage tanks—flood control dams—navy destroyers.

"Armorhide®" coating supplied by J. L. Armitage Company. Write for technical literature.

Visit the Bakelite Exhibit at the Design and Engineering Show at Chicago, Illinois

IMPACT STYRENES
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Products of UNION CARBIDE *Corporation*

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9-5048

Circle 439 on Page 19

I-T-E ELECTRO-CLUTCHES

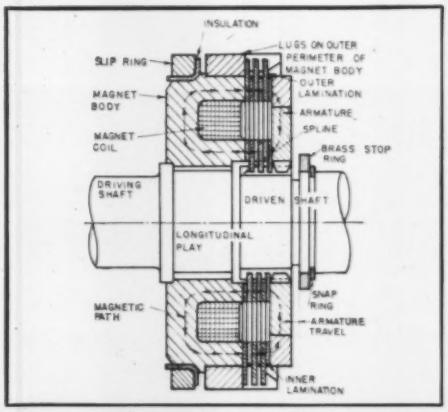
MOST COMPACT

The extra compactness in I-T-E Electro-Clutches means you can get more of them into the same space. This can mean more speed and feed changes for your machines; or it can mean simply a lower cost transmission and housing construction.

Patented closed magnetic circuit. Unlike other clutch types, I-T-E Electro-Clutches feature a patented closed magnetic circuit. Flux lines travel through—not around—the unique all-steel, interleaved laminations to produce tremendous torque in small space. The same laminations also provide the clutching surfaces, giving greater clutching area.

Most durable. The all-steel laminations in I-T-E Electro-Clutches naturally outlast other clutching materials such as plastics, sintered metals, or friction discs. At the same time, no air gap is needed. Hence I-T-E Electro-Clutches are adjustment free and give high, uniform torque throughout their long life. Since they operate in oily conditions, there's virtually no friction loss when disengaged —and heat is better dissipated.

I-T-E Electro-Clutches are available in 60 different models covering a wide range of torque ratings. All operate on safe, dependable 24 v d-c. Write for complete information. I-T-E Circuit Breaker Company, Transformer & Rectifier Division, 19th & Hamilton Sts., Philadelphia 30, Pa.



Principle of operation. Alternate laminations key with perimeter lugs and splined shaft respectively. Rotate freely until magnet coil is energized. Magnetic flux attracts the armature, compressing the laminations with great force, engaging clutch.

Drawing above illustrates type "d" internal drive—photo illustrates type "C" external drive.

I-T-E Electro-Clutches are already in use by these leading companies:

Bullard Fosdick Sundstrand
Giddings & Lewis

I-T-E CIRCUIT BREAKER COMPANY
PHILADELPHIA, PENNSYLVANIA

MEMO
Tom: You ask why SPIROLOX Retaining Rings? well— Here are just a few reasons
This ring alone saved us hours of machining, assembly time. Saved extra lock parts, space, and weight!
Tom note: Full circle (360°) retaining surface!
PISTON PIN RETAINER (Internal use example)
No groove "pop-out" problems here, Tom. That SPIROLOX is in there to stay!
"ROLL-LOCK" CHUCKING TOOL (External use example)
Reusable, too! No loss of circularity or holding power. Think of the savings!
Know how I put that ring in? With a screwdriver! Know how I can get it out? With a screwdriver! No special tools with SPIROLOX, Tom — easy in, easy out!
See? Automatically locks itself in the groove under thrust. Can't wind or unwind!
Here's a retaining job for you! Resists thrust up to its own shear strength!
—And how's THIS for a uniform shoulder? Uniform ring height, too!

FREE SAMPLES FOR ENGINEERING TEST

Spirolox has proven the solution for hundreds of manufacturers. *Test samples* may give you the answer to your problems—or demonstrate there is a better way. Test samples of Circolox, Ramco's newest development in retaining rings are also available. Send us blueprints or sizes needed for tests—and we'll gladly send samples of both types, plus Data Bulletins. Write Ramsey Corporation, subsidiary of Thompson Products, Inc., Dept. B, St. Louis 8, Missouri.

SpirOlox / CircOlox RETAINING RINGS

THE BETTER WAY TO HOLD PARTS TOGETHER!

THE RIGHT RETAINING RING FOR EVERY REQUIREMENT

RAMSEY CORPORATION, St. Louis 8, Mo.
a subsidiary of **Thompson Products, Inc.**

R-307

Cronaflex is durable:

TRADEMARK

Same "second original" makes hundreds of exact copies

The CRONAFLEX "second original" in the picture has already reproduced over a hundred clear, black-line copies. It's good for hundreds more. CRONAFLEX shrugs off kinks and wrinkles, no matter how many times it's passed through a reproduction machine.

The CRONAFLEX matte surface provides the finest pencil and ink acceptance. Lines never smudge. They can be drawn—or erased and redrawn—on either side of the film. You make your corrections right on the CRONAFLEX; your valuable original drawing remains untouched.

CRONAFLEX Engineering Reproduction Films are available in three types: (1) Direct Positive Film, (2) Contact Film and (3) Projection Film. For more information on this revolutionary new line, write: E. I. du Pont de Nemours & Co. (Inc.), Photo Products Department, Wilmington 98, Delaware. In Canada: Du Pont Company of Canada (1956) Limited, Toronto.

This advertisement was prepared exclusively by Phototypography

DU PONT

REG. U. S. PAT. OFF.

Better Things for Better Living . . . *through Chemistry*

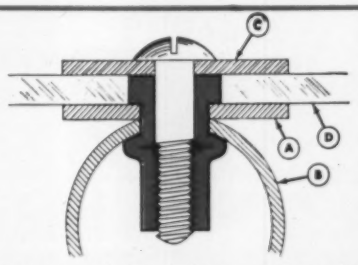
Circle 442 on Page 19

B. F. Goodrich Rivnuts®

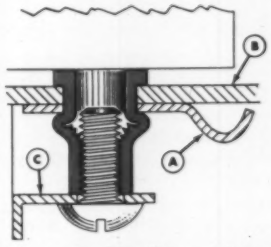
B.F.Goodrich

save time, cut costs by doing...

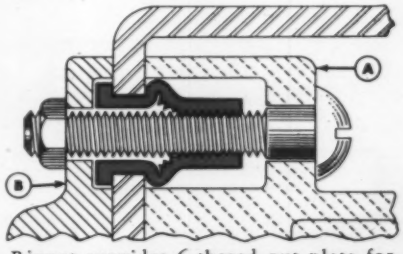
Do you have dual fastening problems like these?



In airplane window seal, Rivnut rivets plate (A) to center post (B), provides nut plate to hold clamp strip (C). Rivnut head serves as spacer for transparent plastic sheets (D). Result: a neat, weather-tight seal!

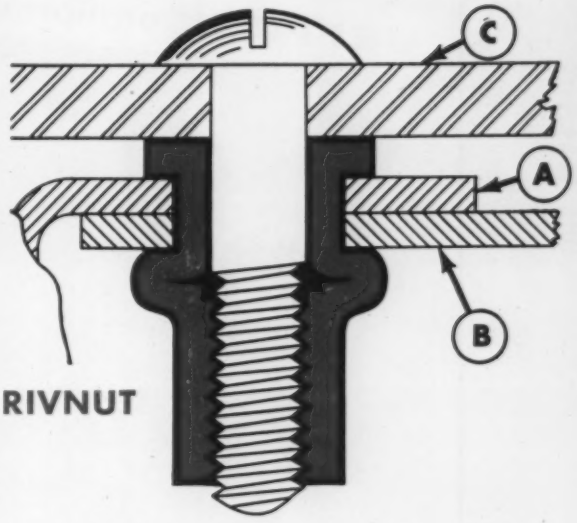


In vaporizer assembly, Rivnut rivets upper flange (A) to casing (B), makes firm, accurate nut plate for attachment to lower flange (C). Rivnut eliminates reinforcing plate. Result: less assembly time, fewer parts, better product.



Rivnut provides 6-thread nut plate for attachment from either end—or *both*. In spotlight assembly, Rivnut replaces awkward welded stud for attaching socket (A). Plug base (B) is attached on other side. Result: fewer operations, lower assembly cost.

TWO JOBS IN ONE OPERATION



B. F. GOODRICH RIVNUTS cut costs and speed assembly because they rivet two parts together, make a firm, accurate nut plate for a third. And they do both jobs in one quick operation! Rivnuts can be installed from one side, take an attachment bolt from either end. They eliminate welding, tapping, clinching.

In the transformer assembly above, one worker fastens the metal cover (A) to the Glastic* sheet (B) with Rivnuts in seconds. Rivnuts then serve as mounting lugs for attaching completed transformer to mounting plate (C).

B. F. Goodrich Rivnuts have speeded up thousands of fastening jobs. They can do the same for you.

SEND NOW FOR FREE RIVNUT DEMONSTRATOR

Demonstrates with motion how you can use Rivnuts to fasten WITH and TO. Explains construction, simplicity of installation. Get your free copy today by writing to: B.F.Goodrich Aviation Products, a division of The B.F.Goodrich Company, Dept. MD-48, Akron, Ohio.

*T. M. Reg. The Glastic Corp.

B.F.Goodrich aviation products

Circle 443 on Page 19

● Check the Jeffrey line when specifying parts or accessories for any of your materials handling jobs. Jeffrey products have been time-tested on original equipment and as replacements in all kinds of industrial applications. Their design, materials and workmanship are of the finest, assuring efficient, low-cost service.

Jeffrey transmission products are widely known for quality and dependability. Many of the most popular types of chain were originated and patented by Jeffrey and since have been adopted as standard throughout industry. Send for complete data. Distributors in principal cities. The Jeffrey Manufacturing Company, 798 North Fourth Street, Columbus 16, Ohio.

JEFFREY

CONVEYING • PROCESSING • MINING EQUIPMENT...
TRANSMISSION MACHINERY...
CONTRACT MANUFACTURING

Miracle Plant! Zoospores of some fungus cover their own length as fast as a Sabrejet. The bacterium *Pseudomonas aeruginosa* (shown many times its size) has been clocked at 31.7 lengths per second. To do as well, proportionate to size, a man would have to run 125 miles an hour.

Miracle Instrument. This anemometer catches a puff of wind wafting less than 1 mile per hour. Its high sensitivity and accurate measurement of wind speed are aided by two MPB bearings in which the shaft rests. Quick starting is result of low initial torque.

Man With Miracles. This is Nick Carter, MPB's Chief Engineer. He helped the anemometer people find exactly the right type of radial retainer bearing that would reduce friction to a minimum, give failure-proof service and help keep original and maintenance costs low.

Miracles in Miniaturization

ACTUAL SIZE

New Age Of Miracles is miniaturization in industry. It's a new frontier as magnificent as the colossal. With MPB bearings the impossible miniaturization often becomes practical; the pretty-good becomes perfect. MPB has the greatest wealth of experience in miniaturization in the bearing industry . . . over 500 types and sizes available . . . specials on request . . . technical assistance and research facilities second to none. You'll want to know more about the subject. For our new catalog write **Miniature Precision Bearings, Inc.,** 104 Precision Park, Keene, N. H.

MPB

Helps you perform miracles in miniaturization

Circle 445 on Page 19

structurally homogeneous

PARKER-KALON stress relieved socket screws

After controlled heating and equally controlled uniform quenching imparting maximum strength, P-K Socket Screws are carefully tempered to assure ductility, proper elongation and high impact strength. This is your assurance that . . . *If it's P-K . . . It's O-K!*

PARKER-KALON DIVISION, General American Transportation Corporation • Manufacturers of Socket Screws, Self-tapping Screws, Screwnails, Masonry Nails, Wing Nuts and Thumb Screws.

Sold Everywhere Through Leading Industrial Distributors — Factory: Clifton, New Jersey • Warehouses: Chicago, Illinois; Los Angeles, California

PARKER-KALON® fasteners

Be sure to see a demonstration of the new JET-SETTER automated fastener feeder

P-K BOOTH 739

DESIGN ENGINEERING SHOW
International Amphitheatre • Chicago
April 14-17, 1958

Circle 446 on Page 19

Avoid costly down-time caused by electrical control failure....

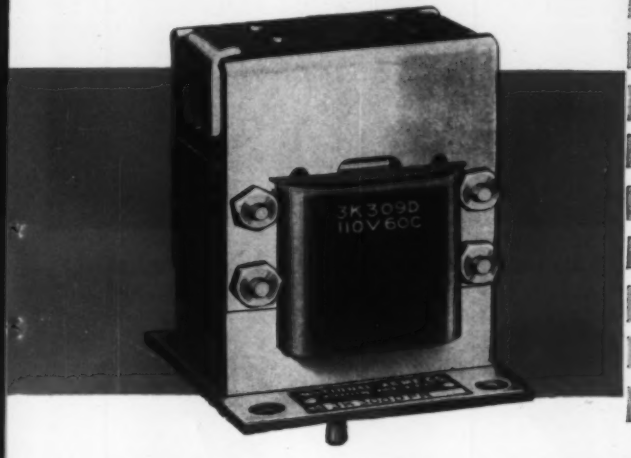
Nothing is more frustrating to the production man than downtime caused by the failure of a minor component. An $85,000 machine tool down because of a failure of a limit switch can be as expensive as if it were caused by a main bearing burnout. National Acme's electrical controls are designed by machine tool designers and built as machine tools are built. That means extra ruggedness, extra dependability but it does not mean extra cost.

GOLD-N-RING CONTROL SWITCHES

Oil-tight, water-tight, dust-tight. Built with heavy duty silver alloy contact points, over-size terminal screws, superior dielectric materials. For full information ask for a free copy of Bulletin ECS-56.

LIMIT SWITCHES

A full line of heavy duty Limit Switches designed originally for machine tool installation but now used wherever extra dependability, extra ruggedness and long life are required. For full information ask for a free copy of our Bulletin EM-51.



NAMCO SOLENOIDS

A full line of standard and custom made Solenoids for AC or DC use. Push or pull types with capacities up to 25 lbs. Bulletin EM-52A provides information on the application, design and installation of Solenoids. Write for your free copy today.

Electrical Manufacturing Division

National Acme

THE NATIONAL ACME COMPANY • 188 E. 131st St. • Cleveland 8, Ohio.

Circle 447 on Page 19

MORE ABOUT THE GARLOCK 2,000

How to Select and Apply

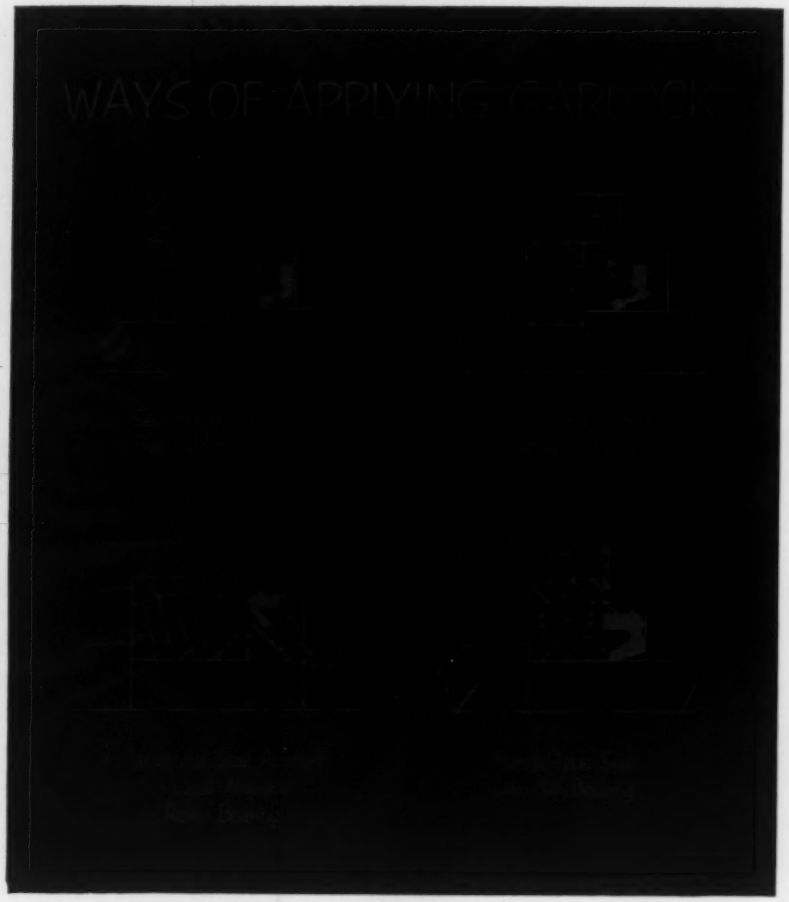
Selecting a Seal

Any ball or roller bearing seal must do two things: (1) It must keep lubricants in; and (2) It must keep dirt and grit out.

Factors to consider when selecting a seal are whether the shaft operates at high or low speed, whether the bearing load is heavy or light and whether the operating temperatures are high or normal. Also remember that the sealing of oil requires a more efficient seal than the retention of grease.

Seal Types

There are, of course, many kinds of seals used to protect bearings to some degree. Unit or lip type seals, such as the Garlock Klozure* Oil Seals illustrated, provide the best protection for automobiles, tractors and industrial machinery.



A

shows a Garlock Springless Klozure Oil Seal used where heavy lubricants are to be contained and dirt excluded.

B

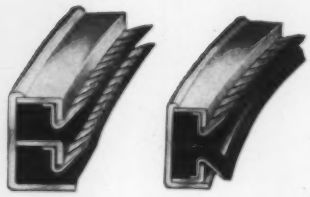
shows a Klozure with finger spring, very efficient for normal and high speed oil sealing on all size shafts.

C

shows a lip type Klozure with garter spring for sealing oil at normal and high speeds on shafts from 1″ to 10″.

D

shows a Klozure oil seal with combination finger and garter spring for use on large shafts operating under severe conditions.

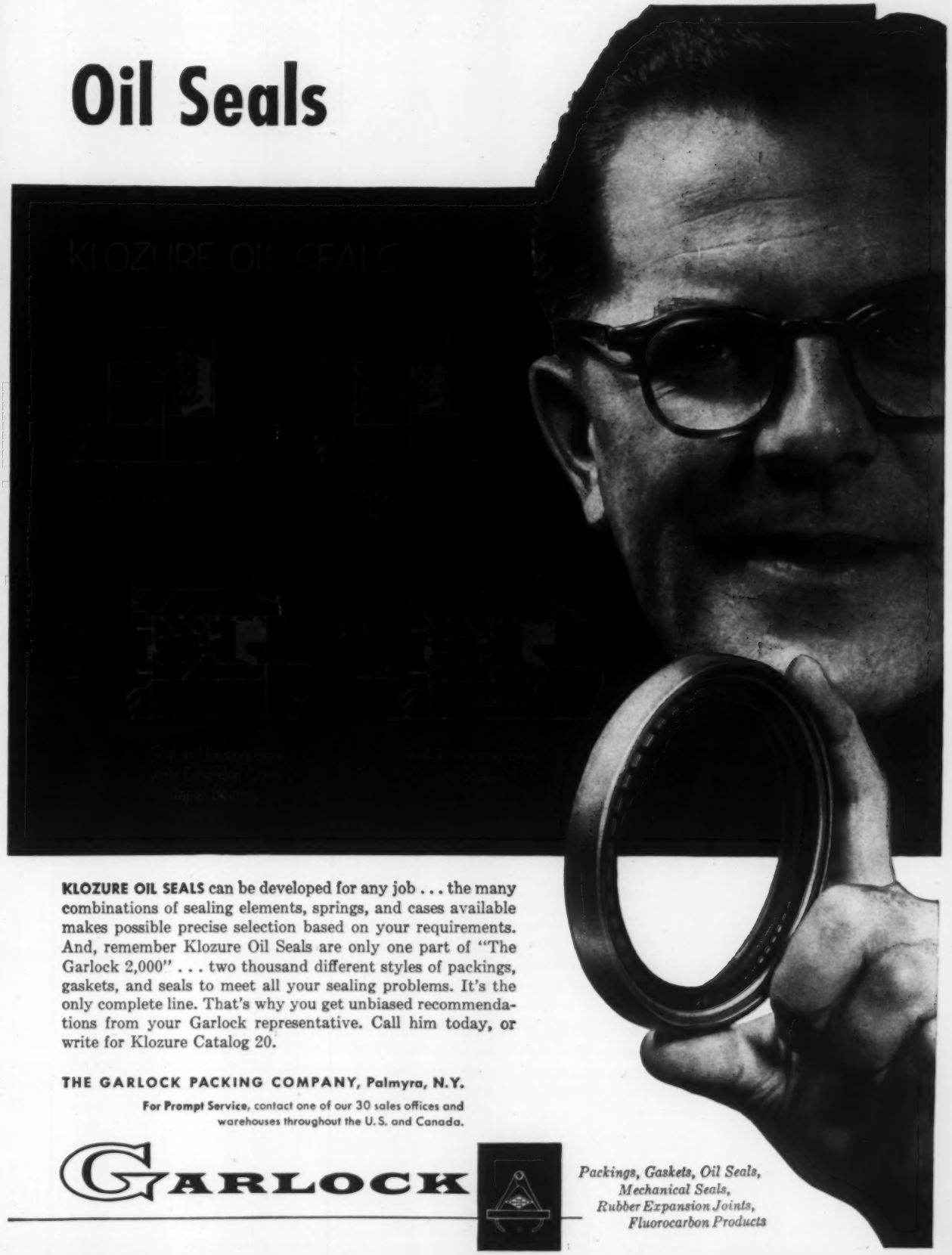


E **F**

Klozure Oil Seals are also available in dual tandem (E) or dual opposed (F) constructions for unusual sealing problems caused by operational or environmental conditions.

*Registered Trademark

Oil Seals



KLOZURE OIL SEALS can be developed for any job . . . the many combinations of sealing elements, springs, and cases available makes possible precise selection based on your requirements. And, remember Klozure Oil Seals are only one part of "The Garlock 2,000" . . . two thousand different styles of packings, gaskets, and seals to meet all your sealing problems. It's the only complete line. That's why you get unbiased recommendations from your Garlock representative. Call him today, or write for Klozure Catalog 20.

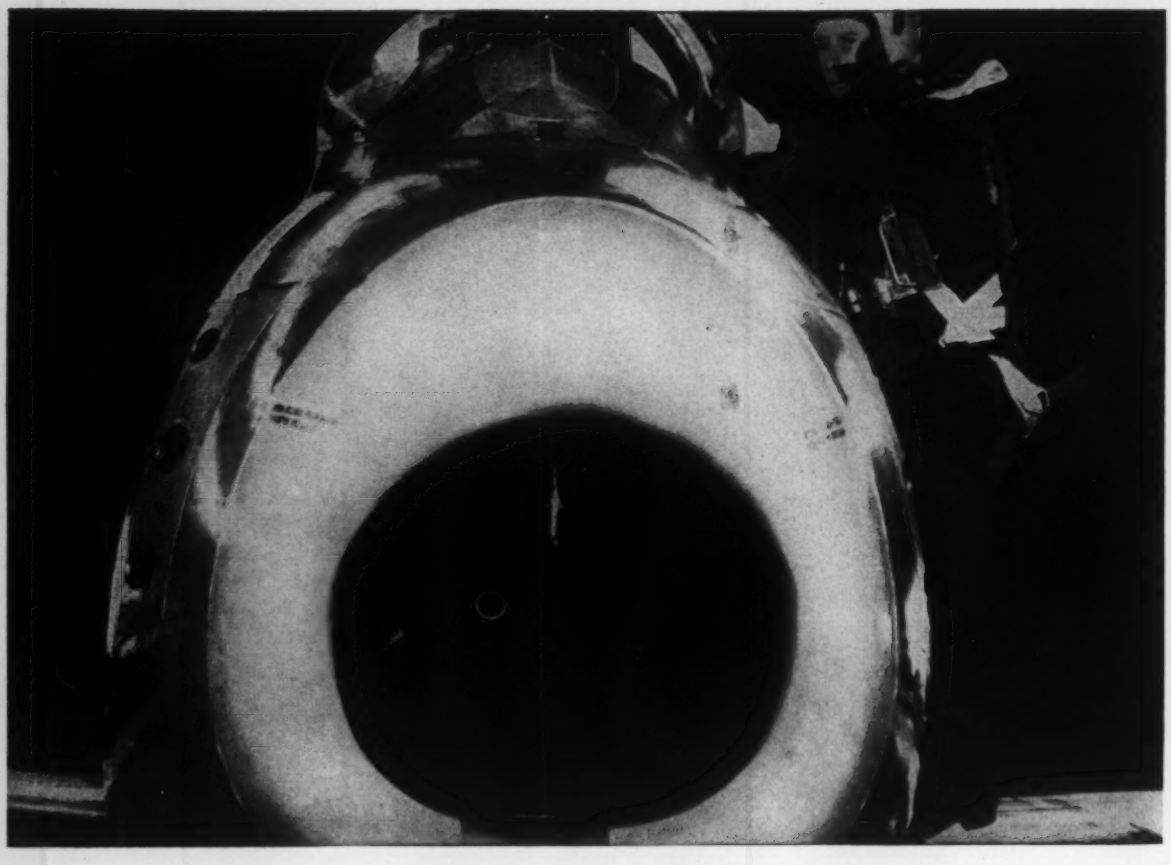
THE GARLOCK PACKING COMPANY, Palmyra, N.Y.

For Prompt Service, contact one of our 30 sales offices and warehouses throughout the U.S. and Canada.

GARLOCK

Packings, Gaskets, Oil Seals, Mechanical Seals, Rubber Expansion Joints, Fluorocarbon Products

Circle 448 on Page 19



in here . . . ***a tough new alloy***

Everything this jet fighter swallows hits those buckets and blades, including nuts, bolts, pebbles, rocks, dirt, sticks and even birds.

Often, the result is a ruined engine, a crippled airplane. That's why Carpenter metallurgists devote a good share of their efforts to improving the tough alloys used for compressor and turbine parts and fasteners.

And now, they've come up with a brand new alloy steel—LAPELLOY "C", U. S. Patent No. 2,816,830.

It is more ductile and has more impact resistance than the conventional Lapelloy long used in jet engines. Its structure is more homogeneous and it has more uniform fabrication properties. Its strength is excellent at both room and elevated temperatures.

New LAPELLOY "C" is made by the exclusive Carpenter MEL-TROL process. MEL-TROL makes possible new standards of uniformity and predictable performance in specialty steels by removing the causes of inconsistent centerline quality so often found in alloys made by conventional methods. In addition to new LAPELLOY "C", Carpenter offers a wide selection of other MEL-TROL alloys for elevated temperature service.

Write for technical data on new LAPELLOY "C" and the MEL-TROL process or ask the Carpenter representative who calls on you. The Carpenter Steel Company, 120 W. Bern Street, Reading, Penna.

Carpenter STEEL

Improved alloys for elevated temperature service

Genuine ALLENs for your king-size holding jobs now available from stock!

1¼" and 1½" sizes are standard

These applications show you the great variety of holding jobs for which designers and engineers are specifying these rugged king-size Allen Hex-Socket Cap Screws. They're genuine Allens, from their heads to their Leader Points. Pressur-formd, to preserve the long fibers uncut throughout their lengths. Highly accurate threads. Leader Points, of course—for fast, true starting. 1¼" and 1½" diameters available immediately from stock—larger diameters are available on special order.

PHOTO: THE OILGEAR CO.

King-size Allen Hex-Socket Cap Screws are used to secure the flanges in this big 12-inch 3000 psi Oilgear Surge Valve.

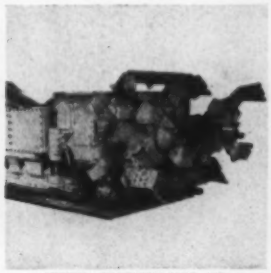


PHOTO: GOODMAN MFG. CO.

King-size Allens secure cutter arms, tilting arms, and elevating cylinders in this massive Goodman Continuous Mining Machine.

PHOTO: SODERHAMN MACHINE MFG. CO.

King-size Allen Cap Screws securely clamp the knives of this large and unusual machine that debarks whole trees.

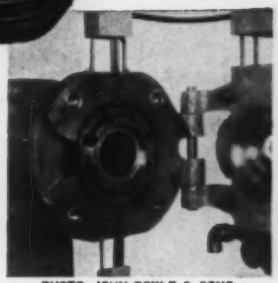
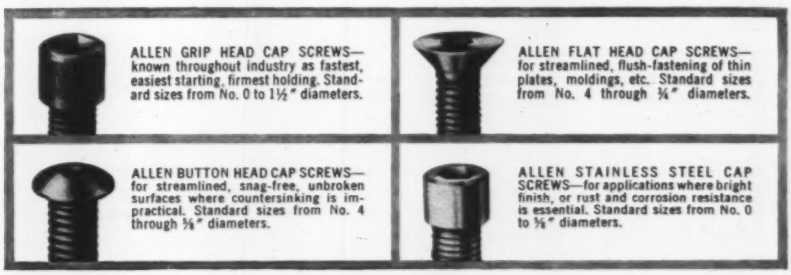


PHOTO: JOHN ROYLE & SONS

King-size Allens in the side-delivery Extruding Head of this Royle machine for application of rubber or plastic in solution.

The cost of Allen Hex-Socket Cap Screws is only a minor fraction of your assembly costs . . . be sure you're getting the timesaving, cost saving advantages of genuine Allens!



ALLEN GRIP HEAD CAP SCREWS—known throughout industry as fastest, easiest starting, firmest holding. Standard sizes from No. 0 to 1½" diameters.

ALLEN FLAT HEAD CAP SCREWS—for streamlined, flush-fastening of thin plates, moldings, etc. Standard sizes from No. 4 through ¾" diameters.

ALLEN BUTTON HEAD CAP SCREWS—for streamlined, snag-free, unbroken surfaces where countersinking is impractical. Standard sizes from No. 4 through ⅜" diameters.

ALLEN STAINLESS STEEL CAP SCREWS—for applications where bright finish, or rust and corrosion resistance is essential. Standard sizes from No. 0 to ⅜" diameters.

FREE! . . . this new "vest-pocket" size Allen Hex-Socket Screw HANDBOOK . . . 112 pages of up-to-date technical information . . . Send for your free copy today.

ALLEN MANUFACTURING COMPANY
Hartford 2, Connecticut, U.S.A.

Stocked and sold by leading industrial distributors everywhere

ALLEN HEAD HEX-SOCKET SCREWS

Circle 450 on Page 19

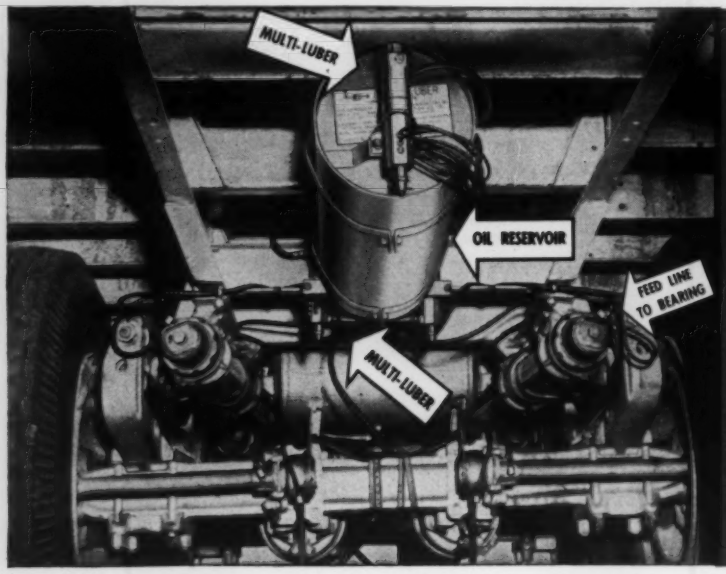
lubri-facts from Lincoln

No. 102 of a series of case histories on the vital role of lubricant application systems in engineering design.

DESIGN ENGINEERS ARE CONSTANTLY DISCOVERING NEW, POWERFUL COMPETITIVE PRODUCT ADVANTAGES IN LOW-COST

Lincoln Power Lubrication Systems

- Assure positive pressure lubrication to all bearings, simultaneously
- Increase machine efficiency on the road, in the plant, in the field
- Pay for themselves in lower operating costs—longer machine life



Case History:

THE FRUEHAUF TRAILER COMPANY

Maximum protection against bearing wear for Fruehauf trailers is achieved through frequent application of small, measured quantities of refinery pure lubricant, under high pressure, to every bearing. Lincoln Multi-Luber* Automatic Power Lubrication Systems eliminate down-time and man-hours for lubrication . . . keep equipment in use, on the road, where it pays dividends.

The Fruehauf Trailer Company is another example of how progressive manufacturers add more sales power to their products . . . by discovering powerful new competitive advantages provided by low-cost Lincoln Multi-Luber Power Lubrication Systems. This tested method of lubricant application permits simultaneous lubrication of all bearings in seconds . . . on transportation equipment, or on any equipment or machinery having multiple bearing points. Assures proper, frequent lubrication . . . flushes bearings as it lubricates . . . extends bearing life and eliminates costly lubrication downtime. Easy to use . . . simple to install . . . precision-built to last.

Add extra sales features to your original equipment with cost-cutting Lincoln Power Lubrication Systems. Air, vacuum or manually operated. Write today for full details. Ask for Engineering Catalog No. 811.

Most trustworthy name in modern lubrication equipment for industrial, automotive, agricultural, construction and other uses.

*Trade Name Registered

Lincoln

LINCOLN ENGINEERING COMPANY

Division of The McNeil Machine & Engineering Co.

5735 Natural Bridge Avenue • St. Louis 20, Missouri

Circle 451 on Page 19

85 Tons of Tie Rods

Though they might remind you of big gun barrels, these massive forgings are tie rods for a 6500-ton hydraulic press constructed by Lake Erie Machinery Corporation, Buffalo, N. Y. Each of the rods is about 36 ft long; the combined weight of all four is slightly under 85 tons.

These pieces were forged, normalized, tempered, and finish-machined in the Bethlehem shops. Machining included threading at both ends. All in all, it was quite an assignment, one requiring a high degree of precision, for the rods had to be identical. No deviation from specifications could be permitted.

Bethlehem makes heavy forgings in an almost endless variety. But please remember, when thinking of Bethlehem, that smaller forgings have their innings, too. Some of the items produced in our drop-forge shops could be carried in your pocket.

We suggest that you check with our engineers when next in the market for either large or small forgings. Press, hammer, drop, or upsetter—Bethlehem makes them all. And you can be sure that our prices and deliveries are fully competitive. Just phone or write our nearest sales office.

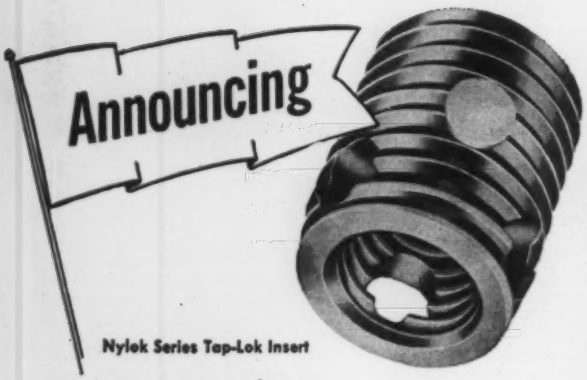
BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation
Export Distributor: Bethlehem Steel Export Corporation

BETHLEHEM STEEL

BETHLEHEM STEEL

Circle 452 on Page 19



Nylok Series Tap-Lok Insert

the *New* NYLOK® Series of TAP-LOK® INSERTS

This new NYLOK Series of self-tapping screw-locking Tap-Lok Inserts meets the demands of the most exacting engineers.

Some of the design features of the NYLOK Series include:

1. The Nylon pellet imbedded in the insert "grows" into the mating threads, giving a higher locking torque.

2. Truncated external thread roots provide a 20% increase in wall thickness . . . proportionately increasing insert strength.

3. Internal threads are supplied the full length of the inserts to Class 2B or 3B specifications.

The Nylon used in the NYLOK Series inserts resists heat, cold, moisture and most commercial solvents. Available in regular and medium lengths . . . NYLOK Series Tap-Lok Inserts meet all torque requirements of MIL N-25027 (ASG).

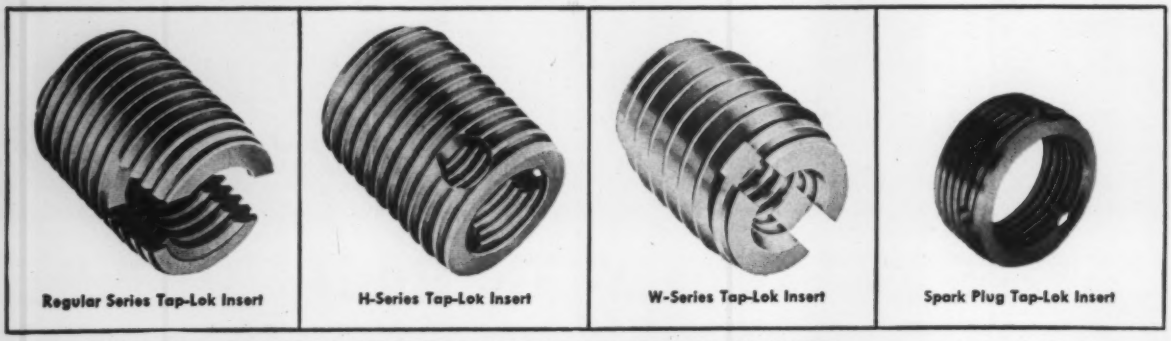
In addition to the new NYLOK Series the full line of TAP-LOK INSERTS includes:

The REGULAR Series—in short and regular lengths. A slotted cutting edge type with Class 2B internal threads for general applications in aluminum and zinc die castings, and sand castings.

The H-Series—in short, medium and regular lengths with Class 2B or 3B internal threads for use in wrought and high strength aluminum and magnesium castings (accepted for aircraft applications).

The W-Series—a brass insert designed for wood applications.

The SPARK PLUG Insert—four standard sizes and special sizes to customer's specifications.



Regular Series Tap-Lok Insert | H-Series Tap-Lok Insert | W-Series Tap-Lok Insert | Spark Plug Tap-Lok Insert

Regular Series Tap-Lok Inserts are manufactured to MIL MS 35914.

There are two Tap-Lok Insert Drivers—one for high production hopper feed runs, and a simplified Driver for low volume installations.

TAP-LOK INSERTS . . . available in case-hardened cadmium plated steel, or stainless steel . . . add more strength to threaded connections in the newer structural materials. No special hole preparations are necessary. Simply drive the TAP-LOK INSERTS into drilled or cored holes. They won't strip and will withstand vibration without loosening. Designed for maximum pull-out strength—they are limited only by the strength of the material in which they are used.

Manufactured under U.S. Patents: 2,455,885 • 2,795,221 • 2,641,948 • 2,704,473 • 2,817,987. Foreign Patents Granted — Other Patents Pending.

Send for TAP-LOK INSERT folders and specification sheets.

GROOV-PIN CORPORATION

1130 Hendricks Causeway, Ridgefield, New Jersey . . . TWX Cliffside 26

IN CANADA: Metal and Wood Fastening Devices Co., 60 Lakeshore Road, Valois, Montreal 33

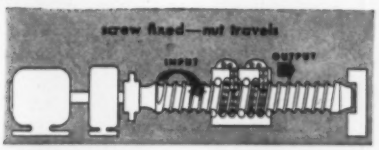
See us at the Design Engineering Show • BOOTH 515

Circle 453 on Page 19

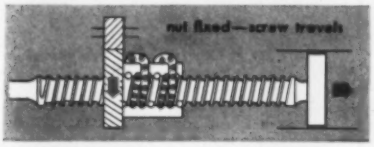
Here's your new ANSWER!

PHOTOGRAPHED ACTUAL SIZE
BALL CIRCLE DIAMETER: 3/16 INCH

WORLD'S SMALLEST ball/bearing SCREW SOLVES CRITICAL MINIATURE POSITIONING/CONTROL PROBLEMS



NUT TRAVELS: When rotary motion is applied to the screw, the b/b nut glides along the axis of the screw on rolling steel balls, converting rotary force and motion to linear force and motion with 4/5 less torque than acme screws.



SCREW TRAVELS: When rotary motion is applied to the b/b nut, the screw glides along its longitudinal axis on rolling steel balls, converting rotary force and motion to linear force and motion with unprecedented efficiency.

An unprecedented achievement in minimum size and weight—maximum efficiency, dependability and service life for ultra-precise controls.

It's another first from Saginaw—and the possibilities it opens up for improved electrical and electronic controls are limited only by your imagination! Radar tuners, missile and rocket guidance and telemetering systems, automatic switchgear, electronic machinery controls are just a few of the applications where this new miniature Saginaw b/b Screw will solve critical positioning/control problems. *It's so compact and light,* you can save substantially on space and weight. *It's so efficient,* (over 90%) you can use much smaller motors and gear boxes. *It's so precise,* you can position components within .0005 inch per inch of travel. *It's so dependable,* you can rely on remarkably long service life even in adverse environments.

You will find our 1958 Engineering Data Book extremely helpful in planning applications, or experienced Saginaw engineers will gladly make specific recommendations without obligation. Just phone, write or mail the handy coupon.

Saginaw

ball bearing Screw

SAGINAW STEERING GEAR DIVISION OF GENERAL MOTORS • SAGINAW, MICHIGAN
WORLD'S LARGEST PRODUCER OF BALL BEARING SCREWS AND SPLINES

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General Motors Corporation
b/b Screw and Spline Operation
Dept. 8MD, Saginaw, Michigan

Please send new engineering data book on Saginaw b/b Screws and Splines to:

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Westinghouse Life-Line "A" motors save $200 a year in rewinding costs alone

...at Rumford Chemical Works, Rumford, R.I.

Westinghouse motors are reliable for 24-hour, 7-day week operation in sulphuric acid manufacture

"In the four years we have used Life-Line® "A" motors, we have never stopped the process because of a faulty motor," reports Mr. John E. Harvey, Plant Engineer at Rumford Chemical Works.

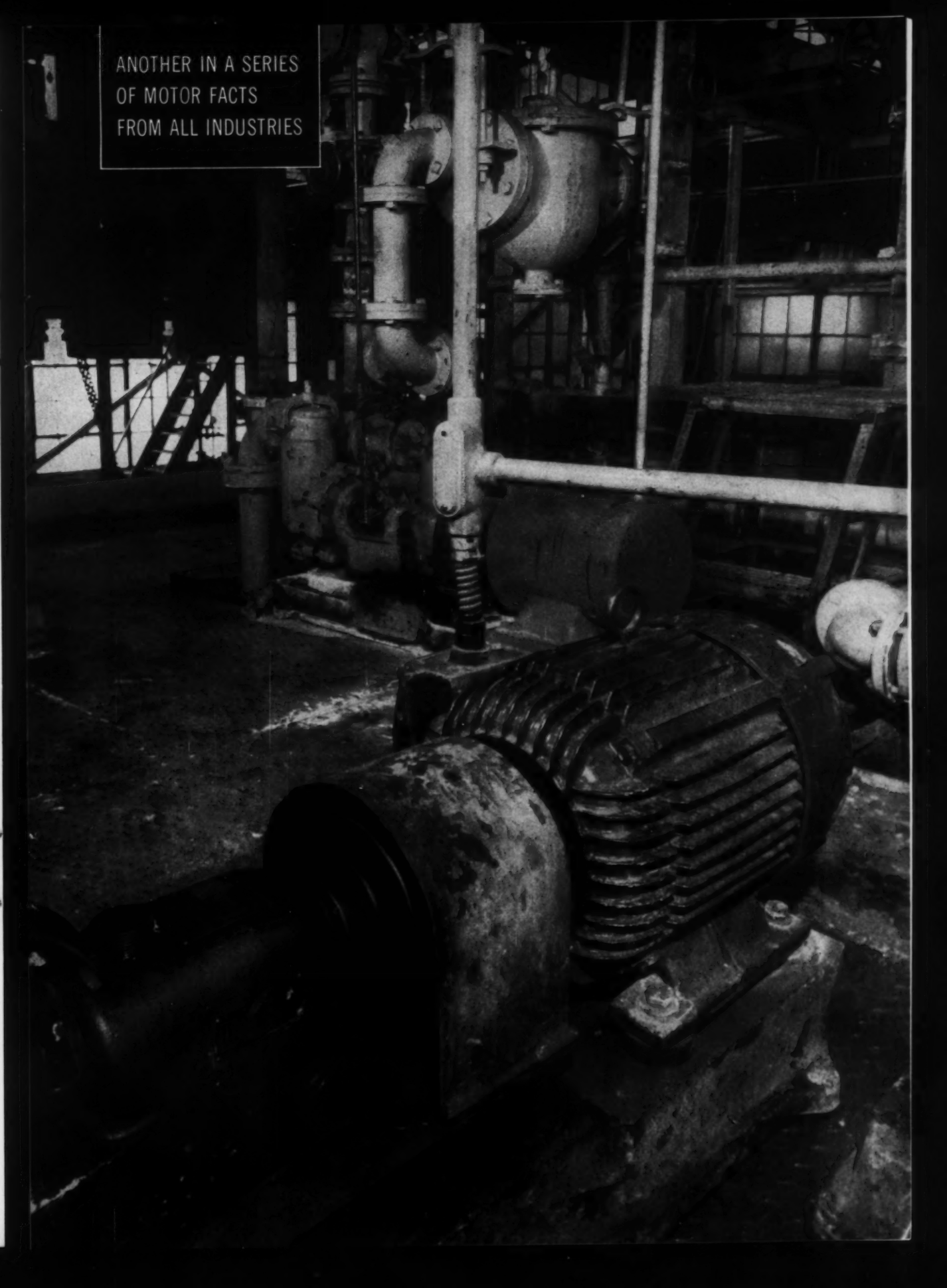
Before installing Life-Line "A" motors, the Rumford Chemical Works had to rewind, on an average, two motors a year at a cost of $100.00 per motor . . . always because the corrosive atmosphere put them out of operation. "We no longer have this problem," reports Mr. Harvey, "since the totally enclosed Life-Line "A" motors give us reliable, continuous operation without fear of damage from spilled acid which could come from leaks or breaks in the pipes."

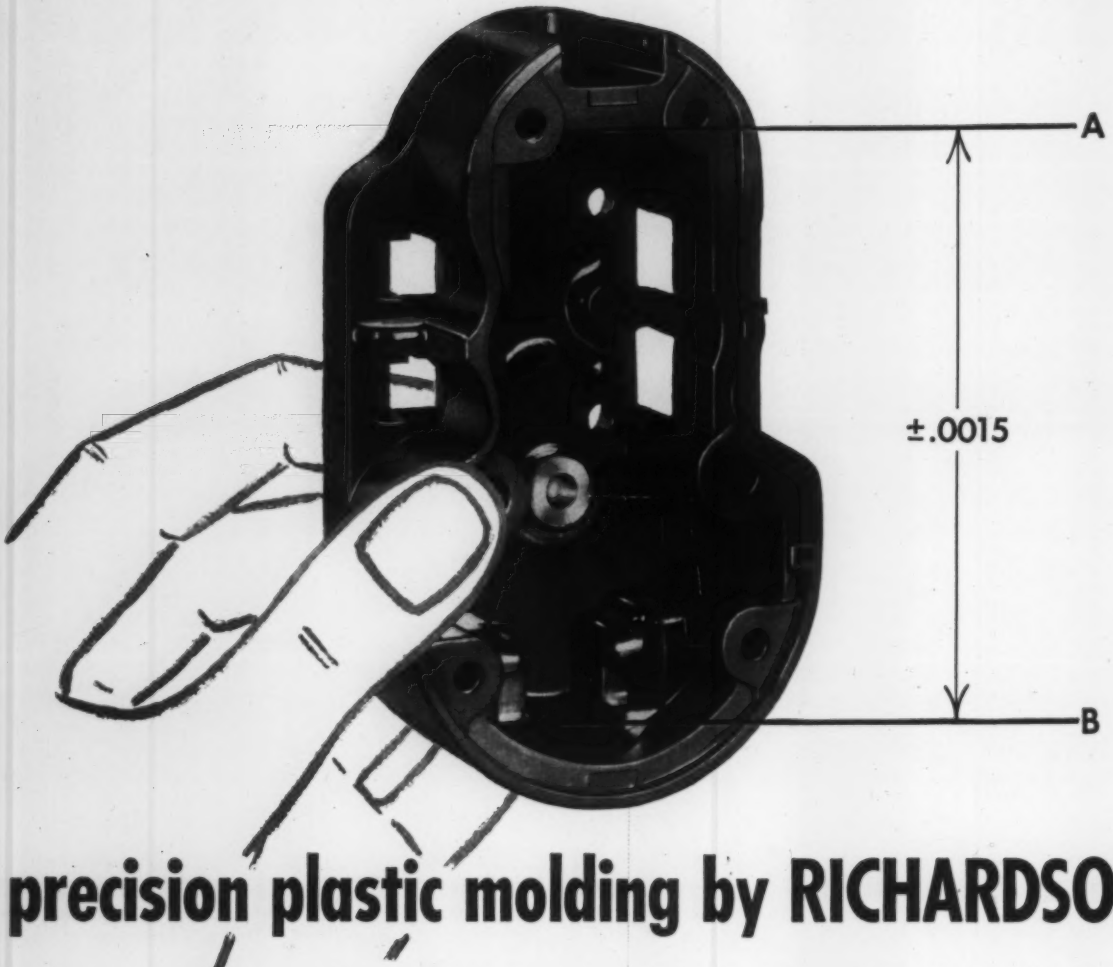
POWER-UP with Life-Line "A" motors designed for modern industry's needs. For more facts, call your Westinghouse sales engineer or distributor. Or write Westinghouse Electric Corporation, P.O. Box 868, 3 Gateway Center, Pittsburgh 30, Pennsylvania. J-22059-R

Mr. Harvey with a 7½-hp Life-Line "A" which drives a sulphuric acid pump in the process at Rumford. This totally enclosed unit has been in operation for over two years.

YOU CAN BE SURE...IF IT'S Westinghouse

Circle 455 on Page 19


ANOTHER IN A SERIES
OF MOTOR FACTS
FROM ALL INDUSTRIES



precision plastic molding by RICHARDSON

This thermostat switch is molded to very close tolerances to position and hold sensitive electrical components securely. For instance, the distance between A and B, anchor points of the thermostat spring, is held to a tolerance of ±.0015". Other molded sections are held to $^{+.000"}_{-.002"}$ tolerances. In spite of temperature changes, the molded part remains dimensionally stable, thereby maintaining the accuracy of the control. This vital switch is used in Hotpoint electric ranges and commercial equipment appliances.

At the suggestion of Richardson engineers, a transfer mold was substituted for the compression mold. The change to transfer molding effected savings in both labor and machine time. Mold life is longer. Flash is completely eliminated from the I.D. of the insert. The transfer mold method also reduced mold maintenance and repair to a minimum with a consequent saving in production "down time."

Richardson Services include research and development where new or special materials are required, engineering design to help you produce the best product most economically, and production facilities for virtually any size or quantity of items in injection, transfer, and compression molding.

Write Dept. 26 for further information or phone—Chicago—MAnsfield 6-8900. There is no obligation.

RICHARDSON PLASTICS
LAMINATED and MOLDED

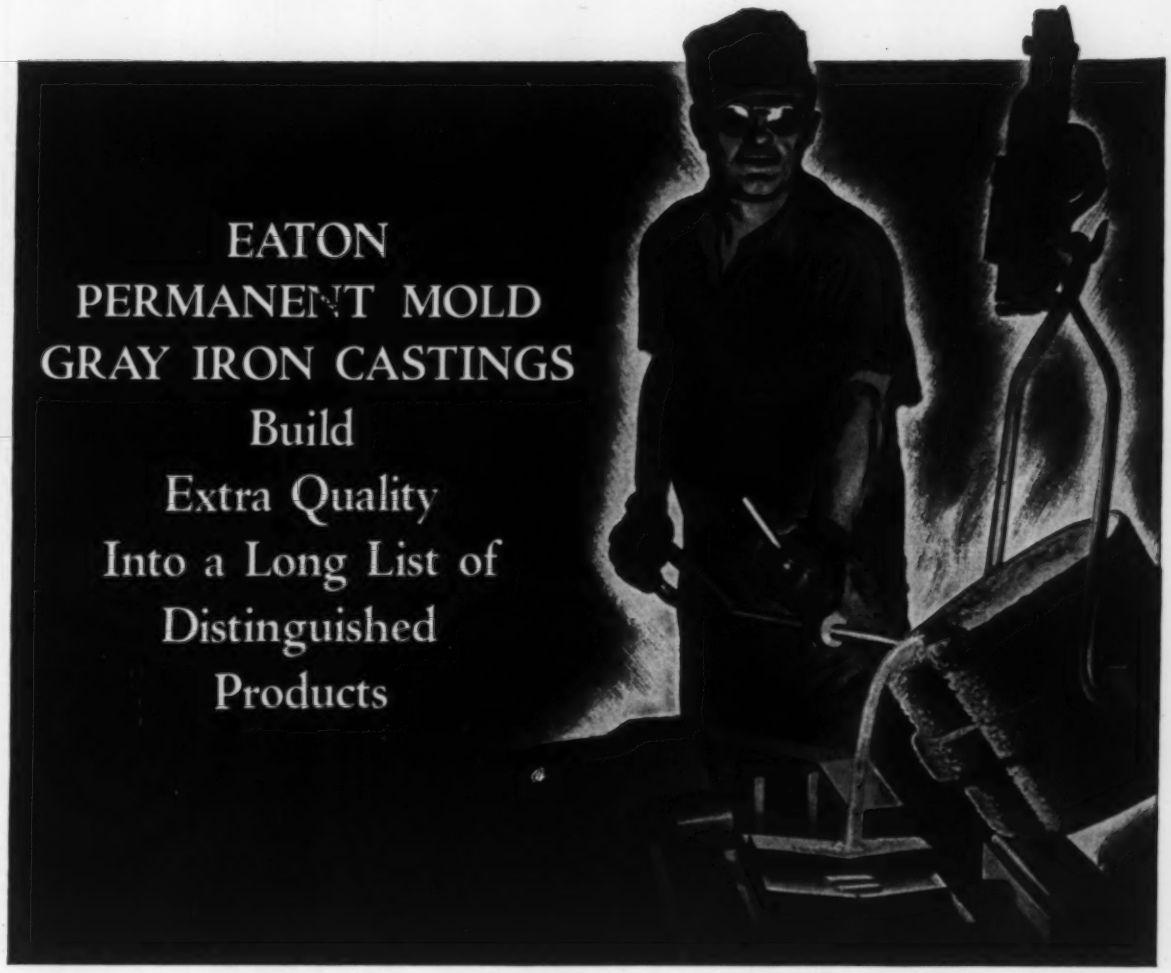
the RICHARDSON COMPANY

Founded in 1858

2795 LAKE STREET • MELROSE PARK, ILLINOIS • SALES OFFICES IN PRINCIPAL CITIES

Circle 456 on Page 19

EATON PERMANENT MOLD GRAY IRON CASTINGS Build Extra Quality Into a Long List of Distinguished Products



Leading manufacturers in practically every major industry have found that the superior structure of Eaton Permanent Mold Gray Iron Castings contribute many worthwhile benefits, not only in the ultimate quality of the finished product, but in manufacturing economies. This is especially true in such fields as motor cars and trucks, refrigeration, air conditioning, domestic appliances, and hydraulic equipment—wherever a dense, non-porous, leakproof structure is a critical requirement. Eaton's advanced production methods, combined with the latest in foundry facilities, assure uniformly high quality and the capacity to deliver on schedule.

Engineers of the Eaton Foundry Division have assisted many of our customers in casting design and process development. Whatever your requirements, our engineers will be pleased to work with you. Why not discuss the advantages of Eaton Permanent Mold Gray Iron Castings applied to your product? Just write or phone—there's no obligation.

Check these Important Advantages:

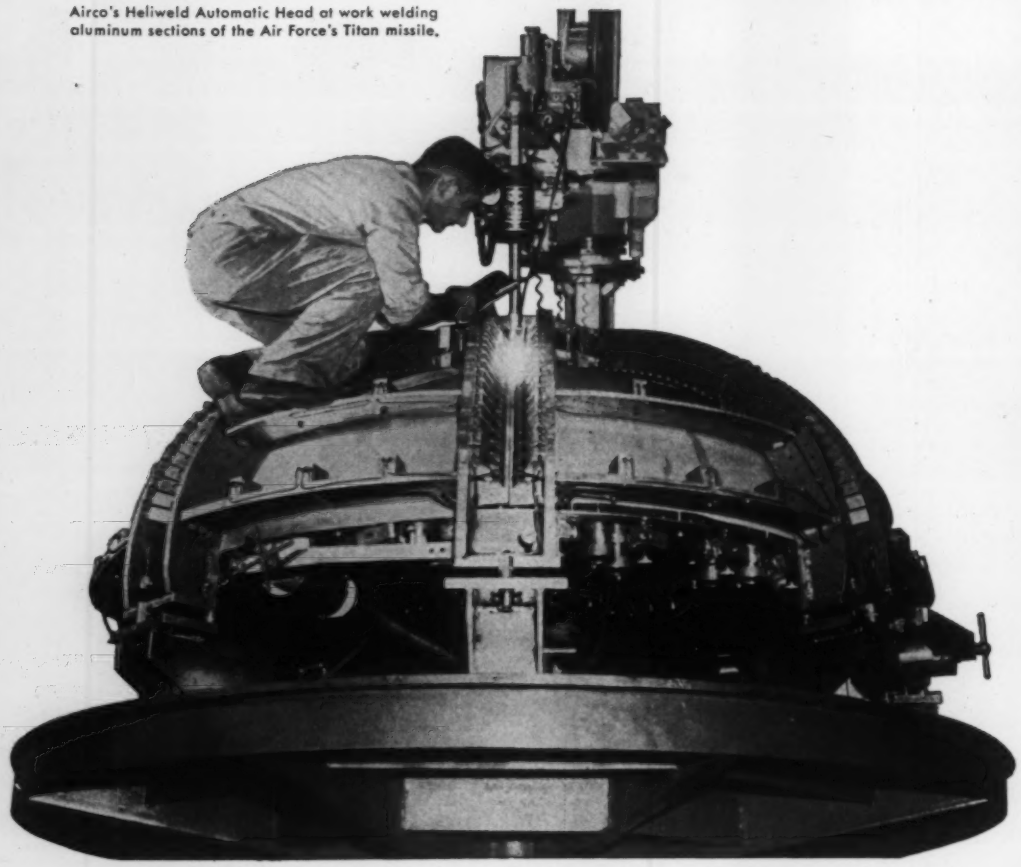
- ★ **Dense, non-porous, homogeneous structure**
- ★ **Freedom from inclusions**
- ★ **Excellent tensile strength**
- ★ **Ability to take a high surface finish**
- ★ **Freedom from leakage under pressure**
- ★ **Intricately cored sections**
- ★ **Uniformity of castings**
- ★ **Higher machining feeds and speeds**
- ★ **Substantially increased tool life**

Send for Illustrated Descriptive Literature

EATON FOUNDRY DIVISION MANUFACTURING COMPANY VASSAR, MICHIGAN

Circle 457 on Page 19

Airco's Heliweld Automatic Head at work welding aluminum sections of the Air Force's Titan missile.



AIRCO HELIWELD PROCESS WELDS MISSILE FUEL TANKS

To weld the thin aluminum fuel tank "orange peel" sections of the Air Force's Titan, the Martin Company uses the largest precision welding tool installation in the United States. It is designed and engineered by Air Reduction's Machine Welding Dept. Key unit in the equipment is the Airco Heliweld Automatic Head, which, with its precision arc voltage control, gives consistent high quality weld results. The unit is flexible, can be used for ferrous or non-ferrous materials.

Heliweld equipment for other industries

Versatile Heliweld units are available for use wherever smooth, high quality welds are required, involving either regular or irregular shapes. Typical applications: tubing, piping, steel strip, electronic components, aircraft, food processing machinery.

For complete information call your nearest Air Reduction office.

SEE IT AT THE AWS WELDING SHOW

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AT THE FRONTIERS OF PROGRESS YOU'LL FIND AN AIR REDUCTION PRODUCT • Products of the divisions of Air Reduction Company, Incorporated, include: **AIRCO** – industrial gases, welding and cutting equipment, and acetylenic chemicals • **PURECO** – carbon dioxide – gaseous, liquid, solid ("DRY-ICE") • **OHIO** – medical gases and hospital equipment • **NATIONAL CARBIDE** – pipeline acetylene and calcium carbide • **COLTON** – polyvinyl acetate, alcohols, and other synthetic resins.

Circle 458 on Page 19

Designing that special drive you need is second nature to Farrel engineers

Pictured are gear drives specially designed by Farrel for two of the company's own products. Both are "specials" engineered to meet customers' requirements for these applications.

This kind of experience — year in and year out — qualifies Farrel engineers to design the "special" you may need; or perhaps the drive that will exactly suit your requirements is already among the hundreds and hundreds of units which have been developed by the company for use in the rubber, plastics, paper, sugar, marine and metalworking industries. The possibility is worth investigating.

The company's Buffalo plant has specialized for many years in the manufacture of gears, gear units and gear-generating machines. This specialization, coupled with the broad knowledge of industry requirements, is a hard combination to beat when you need a "special" gear drive.

Send for descriptive bulletins of Farrel gear units.

FARREL-BIRMINGHAM COMPANY, INC.
ANSONIA, CONNECTICUT
Plants: Ansonia and Derby, Conn., Buffalo and Rochester, N. Y.
Sales Offices: Ansonia, Buffalo, Boston, Akron, Ann Arbor (Mich.), Chicago, Minneapolis, Los Angeles, Salt Lake City, Tulsa, Houston, Baton Rouge, Fayetteville (N.C.).
European Office: Piazza della Republica 32, Milano, Italy

Farrel-Birmingham®

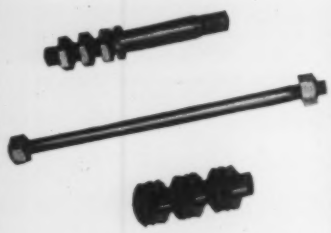
2250 HP UNI-DRIVE
largest drive ever applied to a Banbury® mixer. Gears are generated by the Farrel-Sykes method — a process that assures accuracy of tooth spacing, profile and helix angle.

DOUBLE-REDUCTION GEAR UNIT
one of six specially designed for driving a six-mill tandem for grinding sugar cane. The girl is turning the drive by hand to illustrate the fine precision and balance of the huge double-helical gears mounted on antifriction roller bearings.

FB-1133

Circle 459 on Page 19

World's Biggest Eater Dines Without Interruption



Typical insulator and insulating bolts used on power shovels.

You are looking at 3 million dollars' worth of power shovel, a 14-story monster capable of biting off 70 cubic yards of dirt at a clip.

Continuous operation is essential because downtime on a shovel of this size could top 500 dollars an hour. Reliability is shared by many interrelated parts. Some are made of Synthane laminated plastics.

Why Synthane? Because Synthane laminated plastics have the right combination of properties—dielectric strength, mechanical strength, and ease of machining. And Synthane uses only first-quality raw materials, watches every step in the production and fabrication of the laminate, is deeply concerned about delivery requirements.

Good materials, competent people, excellent tools and workmanship may not guarantee reliability but they're strong assurance of it.

If you are interested in a reliable source of laminated plastics—sheets, rods, tubes, or completely fabricated parts, write for an interesting catalog or call our representative near you.

SYNTHANE

SYNTHANE CORPORATION, 5 RIVER RD., OAKS, PA.

Circle 460 on Page 19

WICHITA CLUTCHES

SELECTED FOR

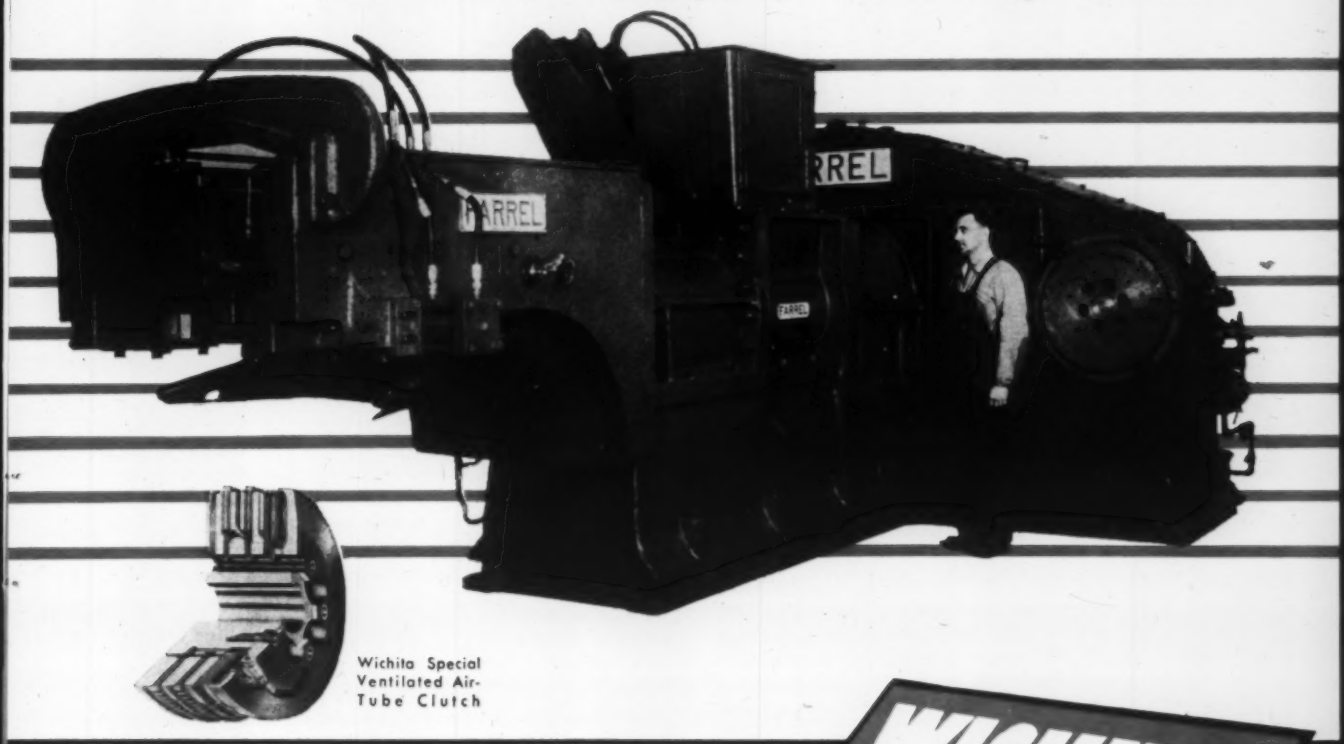
LOAD-CARRYING CAPACITY

SIMPLICITY OF DESIGN

EASE OF MAINTENANCE

"Wichita Clutches were selected for use on the basis of their small diameter for load-carrying capacity, ease in replacement of wearable parts, simplicity of design, and ability to handle the severe loading conditions imposed on them in extruder service. They benefit our extruding machines because frequent stopping and starting of a machine is permitted without stopping and starting of the motor. This stopping and starting occurs between 700 and 1000 times on a twenty-four hour basis. We consider the Wichita Clutch, a very satisfactory item that is well-designed, compact and easy to maintain." These statements are from the men who are responsible for the design and engineering of extruding machines at Farrel-Birmingham Company, Inc., Ansonia, Conn.

on Farrel-Birmingham Extruding Machines



Wichita Special Ventilated Air-Tube Clutch

A Wichita Engineer can Show You why Wichita Clutches are SUPERIOR!

Brehm-Lahner, Inc., Detroit, Michigan
L. H. Fremont, Cincinnati, Ohio
W. G. Kerr Company, Pittsburgh, Pa.
Smith-Keser & Co., Avon, Conn., Philadelphia 44, Pa., and New York, N. Y.
Frank W. Yarline Co., Chicago, Illinois
Larry W. McDowell, Long Beach, California
Andrew T. Lobel, Denver, Colorado
Robert R. King Co., Cleveland, Ohio
Norman Williams, Houston, Texas
Allied Transmission Equipment Co., Kansas City 8, Missouri
Donald E. Harman, Dallas, Texas
C. Arthur Weaver, Richmond, Virginia
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Dominion Power Press Equipment, Ltd., Burlington, Ontario, Canada
R. E. Kunz, Seattle 4, Wash.
W. G. Ballantyne Co., Portland 4, Ore.
Bates Sales Co., St. Louis 1, Mo.

WICHITA Clutch COMPANY, INC.
WICHITA FALLS, TEXAS, U.S.A.

Circle 461 on Page 19

DESIGNING WITH ALUMINUM

This is one of a series of information sheets that discuss the properties of aluminum and its alloys with relation to design. Extra or missing copies of the series supplied on request. Address: Advertising Dept., Kaiser Aluminum & Chemical Sales, Inc., Department PD-1, 919 N. Michigan Ave., Chicago 11, Ill.

NO. 27

THE USE OF ADHESIVES IN FABRICATING ALUMINUM PRODUCTS

LOW COST, VERSATILITY, EASY APPLICATION AND GOOD PHYSICAL AND CHEMICAL PROPERTIES ARE AMONG THE ADVANTAGES OF USING ADHESIVE BONDINGS IN FABRICATING ALUMINUM PRODUCTS.

ALTHOUGH most proprietary adhesives are compounded for specific bonding jobs where certain properties are necessary, they are generally composed of the types listed in Table I. As the table shows, there are many methods of bonding, plus a variety of curing schedules. This versatility of adhesive bonding techniques and joints is the reason for their rapidly expanding use with aluminum. The simplicity of adhesive bonding has also contributed to this success. And the low cost of adhesives has helped them to gain access to jobs formerly held only by solders.

Design Considerations

Design possibilities with adhesively bonded aluminum structures are limited only by extremes of stress, temperature and corrosive environment. Through the use of adhesives, aluminum can be joined to many different materials in one operation.

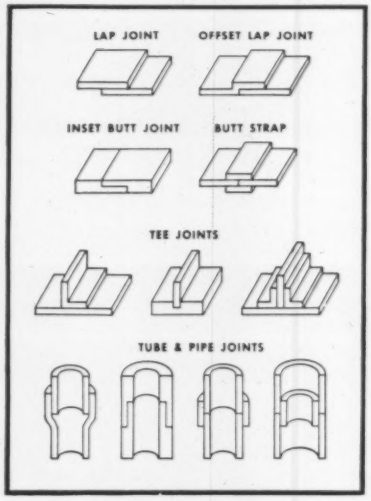
There is only one special consideration in designing for the use of adhesives in joining aluminum; peeling stresses should be kept as low as possible. In some cases it may not be possible to avoid them, but proper joint design will reduce them greatly, thereby assuring a long service life. Figure 1 shows how joints may be designed to minimize peeling stresses which might otherwise exceed the strengths of the adhesives or the materials being joined.

Pretreatments

The pretreatments used in adhesive bonding of aluminum are concerned only with cleaning the surface. In most cases, it is not even necessary to remove the metal's natural protective oxide coating. The cleaning treatment should be selected with joint strength requirements in mind.

For lower strength joints, the ordinary mill finish of aluminum is clean enough. Solvent degreasing to remove thin films of production and handling oils is necessary for intermediate strength joints. Where the adhesive bond must develop the greatest strength possible, a chromic-sulfuric acid dip is usually recommended as the best chemical cleaning method. When a variety of materials are to be bonded together, it may be necessary to use several different cleaning methods on the joint areas before bonding.

FIG. 1



Methods of Applying

The adhesives themselves may be applied by any of several techniques depending upon the nature of the adhesives and the desired properties of the joint. Roller coating is particularly effective for high speed application of a thin coat of adhesive, as in the production of laminates. Various building materials are currently being adhesively laminated with aluminum foil to increase their thermal insulation properties.

For more limited areas, the adhesives may be applied by brush, blade or spray, which are the more familiar methods. However, certain adhesives are being adapted to mass production practice by their manufacturers who are turning them out in film form. This film is then cut into sheets, ribbons or special shapes which follow the contours of specific joint areas. These precut shapes are then assembled with the metal parts before curing.

Curing

Curing processes for adhesives used in bonding aluminum vary considerably with their type and form. The length of curing time may range from three seconds to 76 hours or more depending upon the type of adhesive and whether or not heat and pressure are applied to the assembled joint. Table I shows the curing times generally used with different types of adhesives. Either heat or pressure, or both, must be used to obtain the highest bond strengths.

Properties of Adhesive Bonds

Although adhesives have been used extensively in bonding aluminum and other metals in jewelry, electronic components and other relatively noncritical items, they can also be used where strengths in the neighborhood of 8,000 psi are required in tension or shear. Table II shows the strengths attainable with various adhesives when used to bond aluminum to aluminum. In general, adhesives are resistant to water and hydrocarbons, an important factor to the manufacturers of containers.

TABLE I

ADHESIVES COMMONLY USED IN BONDING ALUMINUM*

Type	Usual Bonding Methods	Common Curing Time	Resistance to		Performance in Use		Typical Applications
			Water	Hydrocarbons	Structural	Non-Structural	
Polyvinyl Acetates	Solvent Release Water Evaporation Reactivation	At 250°F–350°F, 3 sec	Poor to Fair	Good to Excellent	Poor	Excellent	Aluminum to aluminum, glass, ceramics, mica, wood, cork, leather, cloths, paper and many plastic films.
Cellulose Nitrates	Solvent Release	At room temp. 90 min–24 hr	Excellent	Excellent		Good	Aluminum to aluminum, glass, wood, leather, cloths, thermoplastic resins, etc.
Natural Rubbers	Solvent Release Pressure Vulcanization Water Evaporation	Room temp. 24 hr, 260°F–350°F, 10–30 min	Excellent	Poor	Poor	Excellent	Aluminum to aluminum, tile, glass, wood and metal attachments.
Synthetic Rubbers	Solvent Release Pressure Vulcanization Water Evaporation	Room temp. 24 hr, 260°F–350°F, 5–30 min	Excellent	Poor to Good	Poor	Excellent	Aluminum to rubbers, fabrics, foils, plastics, etc.
Alkyds	Contact Pressure at room temp.	10 min–24 hr	Excellent	Excellent	Fair	Excellent	Aluminum laminations and as sealer.
Epoxys	Catalyst Heat Contact Pressure	12–76 hr 10 min–24 hr	Excellent	Excellent	Excellent	Excellent	Aluminum to aluminum, glass, ceramics, many plastics, cyclized rubbers and wood.
Phenolics	Heat and Pressure	5–10 min	Excellent	Excellent	Good	Excellent	Aluminum to aluminum, wood and glass. Adhesive modifiers.
Phenolic-vinyl	Heat and Pressure	5–45 min	Excellent	Excellent	Excellent	Excellent	Aluminum to aluminum and wood.
Phenolic-polyvinyl butyral	Heat and Pressure	5–45 min	Excellent	Excellent	Good	Excellent	Aluminum to aluminum, wood, synthetic rubber and plastics.
Phenolic-polyvinyl formal	Heat and Pressure	5–45 min	Excellent	Excellent	Excellent	Excellent	Aluminum to aluminum and wood (aircraft construction).
Phenolic-Neoprene	Heat and Pressure	15–30 min	Excellent	Excellent	Excellent	Excellent	Aluminum to aluminum, wood and many plastics.
Phenolic-Buna-N	Heat and Pressure	15–30 min	Excellent	Excellent	Excellent	Excellent	Aluminum to aluminum, brake linings and electrical assemblies.

*Many proprietary adhesives are formulations consisting of a number of basic resin types compounded to achieve specific properties for a specific application.

Some of them offer great resistance to impact in shear, while others maintain their strengths at temperatures higher than 400°F.

Cost Advantages

Today, adhesives range in price from thirty-five cents to five dollars per pound. The lower priced adhesives are the type most generally used in making laminates, the more expensive types for seam bonding. Because adhesives are applied at eight to nine pounds per 1000 square feet, the most expensive adhesive bond costs only one-third the price of an equivalent soldered joint.

For further information and assistance in design or application of adhesives to aluminum, contact the Kaiser Aluminum sales office listed in your telephone directory. Kaiser Aluminum & Chemical Sales, Inc., *General Sales Office*, Palmolive Bldg., Chicago 11, Illinois; *Executive Office*, Kaiser Bldg., Oakland 12, California.

TABLE II

STRENGTH RANGE OF ADHESIVE BONDS
Aluminum to Aluminum

Type	Typical Cure Schedule	Approx. Tensile-Shear Al to Al Bonds, psi	Specific Application
Natural and Synthetic Rubbers	Pre dry 1 hr/150°F 5 min/300°F/300 psi	1,150	Aluminum name plates to appliances.
Polyvinyl Acetates	Solvent Release: 230–250°F 5–10 min 350°F ½–2 sec	1,500	Aluminum sheet and foil to masonite. Aluminum foil to paper.
Phenolic Blends	60 min at 350°F and 150 psi	4,200	Aircraft structures.
Epoxys	2 hr at 150°F 10 min at 300°F	6,000 to 8,000	Honeycomb Sandwich and aircraft structures.

see our catalog in PRODUCT DESIGN FILE or write for copy

KAISER ALUMINUM

THE BRIGHT STAR OF METALS

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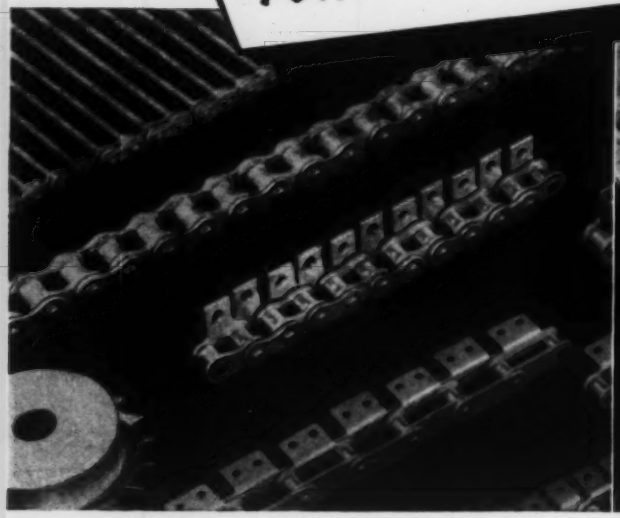
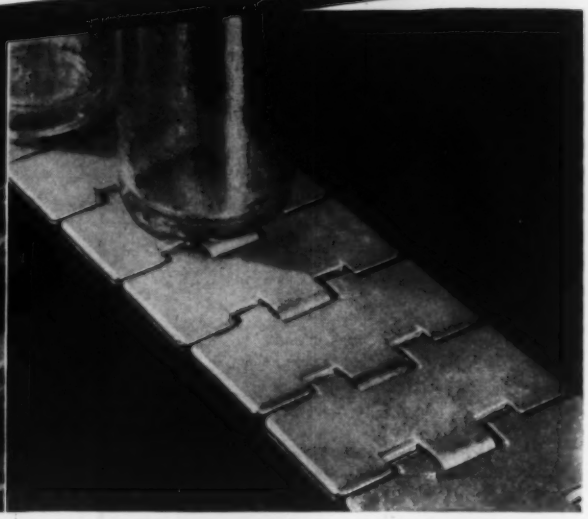
Circle 462 on Page 19

REDUCE WEAR...CORROSION...COSTS WITH ATLAS CONVEYOR AND POWER TRANSMISSION CHAINS





ATLAS ROLLER CHAIN

Cuts Drive Costs 100%

Tests prove Atlas Electrolized Roller Chain on power drives outlasts others by as much as 100% . . . possesses higher tensile strength than other corrosion resistant chain . . . has a lower coefficient of friction to reduce power losses. It meets the most exacting requirements where corrosion resistance is a factor.

Here's the chain that makes it possible for you to re-evaluate the specifications of your transmission drives. From the standpoint of cost, efficiency and longer wear it allows you to specify corrosion resistant chain on drives previously ruled out due to high cost and short chain life.

Atlas Roller Chain, Sprockets and Flexible Couplings are precision matched to operate as a power team for peak efficiency. Team up your power drives with this power team for longer life at lower operating costs.

ATLAS FLAT-VEYOR

Resists Corrosion . . . Moves Smoother

Here's the conveyor chain that is easier to clean . . . stronger for load carrying. Lower coefficient of friction and precision construction assures smoother operation . . . allows plates to "float" along with no drag, chatter or vibration. Wider bearing design reduces wear to less than one-half that of other corrosion resistant chain. Has higher tensile than stainless steel . . . costs 40% less.

Atlas Electrolized Flat-Veyor is available in 3¼", 4", 4½", 6", 7½". Write for full data.

ATLAS CHAIN & MANUFACTURING CO.

West Pittston, Pa.

ATLAS

CHAINS SPROCKETS COUPLINGS

Waldes Truarc GRIP RINGS Replace Expensive Parts... Reduce Manufacturing Costs...Eliminate Rejects

WALDES TRUARC SERIES 5555 GRIP RING*

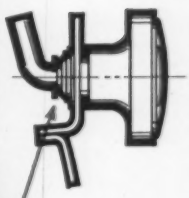
application: external for shafts

range: .077 in. — .755

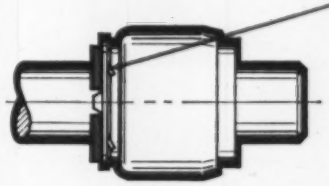
The Waldes Truarc Grip Ring requires no groove, holds fast by friction forces, can be used again and again. It provides a positioning shoulder secure against moderate thrusts or vibration. The ring's unusually large radial width exerts considerable frictional hold against axial displacement.

*U. S. Pat. No. 2,574,034

Rings cut costs 33%, eliminate rejects

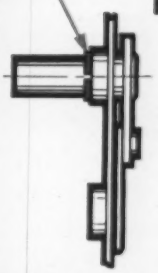


B & J Tool uses series 5555 grip ring to secure parts of damper control made for Vulcan Radiator. Shaft formerly was machined down to provide coil spring shoulder, often broke during bending operation. (Rejects ran as high as 80%!) New design eliminated rejects and field failures, cut production costs 33%.



Rings save $300 per die, $.03 unit

Ray Oil Burner Co. uses a Truarc series 5555 grip ring in fuel pump drive shaft to position seal and drive it to assure continuous rotation with shaft. Original design used complicated die-cast collar and driver which required special groove and shoulder. Savings: $300 per die for each size manufactured, $.03 per part.



Rings save $32.42/M:

Swift Business Machine Co. replaced collars and set screws in hollow shaft assembly of its adding machine with series 5555 grip rings, saving $32.42 per 1000 units. Rings require no groove, make possible positioning adjustments without slippage encountered when set screws were used.

Whatever you make, there's a Waldes Truarc Ring designed to save you material, machining and labor costs, and to improve the functioning of your product.

In Truarc, you get

Statistically Controlled Quality from engineering and raw materials to the finished product. Every step in manufacture watched and checked in Waldes' own modern plant.

Complete Selection: 36 functionally different types. As many as 97 standard sizes within a ring type. 5 metal specifications and 14 different finishes. All types available quickly from leading OEM distributors in 90 stocking points throughout the U. S. and Canada.

Field Engineering Service: More than 30 engineering-minded factory representatives and 700 field men are at your call.

Design and Engineering Service not only helps you select the proper type of ring for your purpose, but also helps you use it most efficiently. Send us your blueprints today . . . let our Truarc engineers help you solve design, assembly and production problems . . . without obligation.

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RETAINING RINGS

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Please send new, descriptive catalog showing all types of Truarc rings and representative case history applications.

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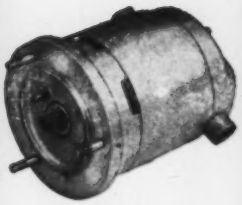
M D940

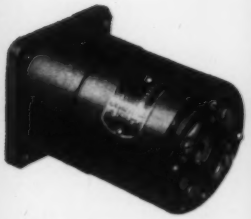
Consult the Yellow Pages of Your Telephone Directory for Name of Local Truarc Factory Representative and Authorized Distributor.

"PONY POWER" MOTORS

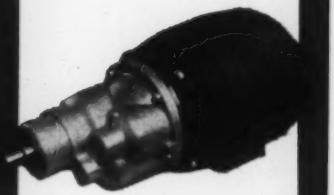
that give stamina to your products



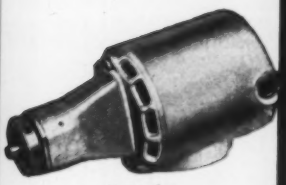
A rugged high-torque, high-speed motor.



Radar voltage regulator gear motor.



Motor with efficient spur gear speed reducer.



Motor for high-speed grinder.

Lamb Electric ***fractional*** horsepower motors, like the small horses of the famed western-pioneer-day Pony Express, are developed for *stamina.*

Their dependability, and efficiency (optimum weight-size-horsepower ratio) are qualities that result from proper design and careful manufacture by personnel with many years of experience in the small motor field.

May we demonstrate how Lamb Electric Motors can bring these advantages—and also perhaps lower costs—to *your* products?

THE LAMB ELECTRIC COMPANY • KENT, OHIO

A Division of American Machine and Metals, Inc.

In Canada: Lamb Electric — Division of Sangamo Company Ltd. — Leaside, Ontario

If you are interested in any of the above motors write and we shall be glad to send full information.

Lamb Electric

SPECIAL APPLICATION FRACTIONAL HORSEPOWER **MOTORS**

Circle 465 on Page 19

Circle 466 on Page 19→

Claymont's new Fabrications Shop is completely equipped to produce large industrial and structural weldments, as well as job-shop steel plate fabrications of all kinds. Integrated facilities make Claymont a reliable source of quality steel plate and plate products for industry.

by d'Arazien

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CHECK CLAYMONT FOR—Alloy Steel Plates • Carbon Steel Plates • Stainless-Clad Steel Plates High Strength Low Alloy Steel Plates • CF&I Lectro-Clad Nickel Plated Steel Plates • Pressed and Spun Steel Heads • Manhole Fittings and Covers • Fabricated Steel Products Large Diameter Welded Steel Pipe

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5743

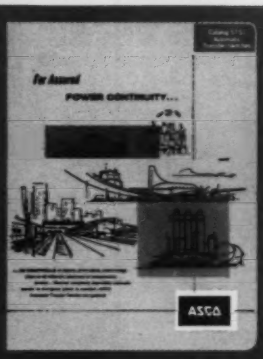
ASCO literature simplifies choice of electromagnetic control

New catalogs offer design engineers important reference tools

MASTER CATALOG 57-S

More than a catalog, this complete volume supplies comprehensive design engineering data on automatic transfer switches, remote control switches, contactors, relays, solenoids, and electric plant control.

For the engineering specialist who is concerned with components of the ASCO electromagnetic control line, individual catalogs are available covering:



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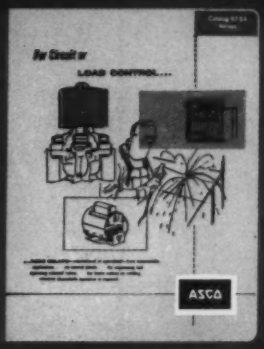
. . . designed to transfer a load automatically from a normal source to an emergency source upon failure or reduction in voltage of normal source. For all classes of load, mechanically or magnetically held.

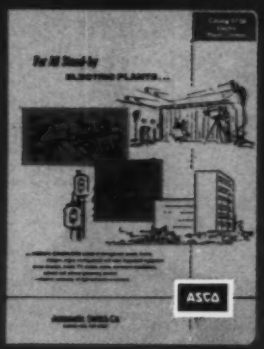
57-S2 REMOTE CONTROL SWITCHES
. . . for convenient and accessible control of power and lighting circuits from any number of control stations. For all classes of load, mechanically held.

57-S3 CONTACTORS
. . . designed to allow unlimited combinations, including multi-pole, special contact arrangements and materials, and other "engineered to fit" features. For all classes of load, normally open and normally closed, magnetically held.



57-S4 RELAYS
. . . magnetically and mechanically held in unlimited pole combinations — plus a highly diversified line of special purpose relays listed as standard catalog items.

57-S5 SOLENOIDS
. . . A-C and D-C, catalog listed or engineered to your requirements.



57-S6 ELECTRIC PLANT CONTROLS
. . . complete systems and components, paralleling, changeover, and alternating panels, load-demand controls, battery chargers and adapter units.

Additional technical literature . . .

Also available is the ASCO engineering study, "Factors to Consider in the Selection of Automatic Transfer Switches."

Catalog 201 on ASCO Solenoid Valves covers more than 1300 types — 2-, 3-, and 4-way with standard, explosion-proof or watertight enclosures—in a wide range of body materials.

VISIT US AT THE DESIGN ENGINEERING SHOW BOOTHS 481, 483 AND 485

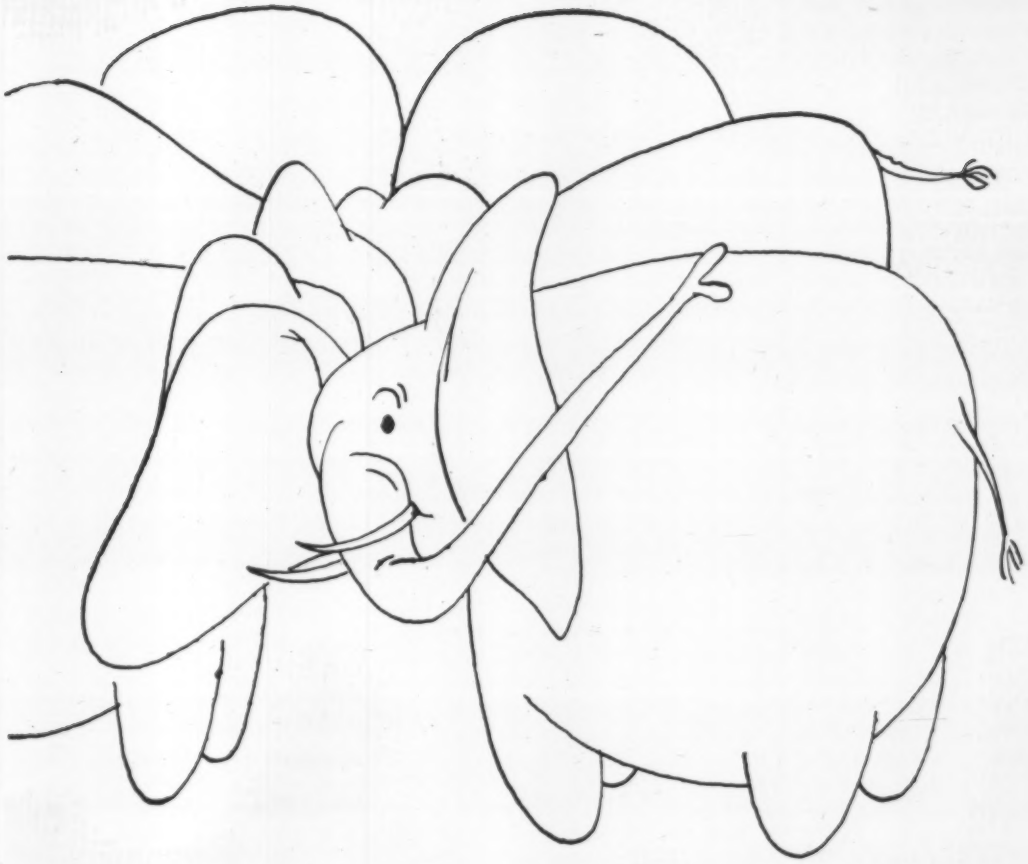
Any of these important reference tools may be had simply by writing Automatic Switch Company — *on company letterhead only, please.*

Automatic Switch Co.
54-A Hanover Road, Florham Park, New Jersey
FRontier 7-4600

ASCO

Circle 437 on Page 19

something big on the move



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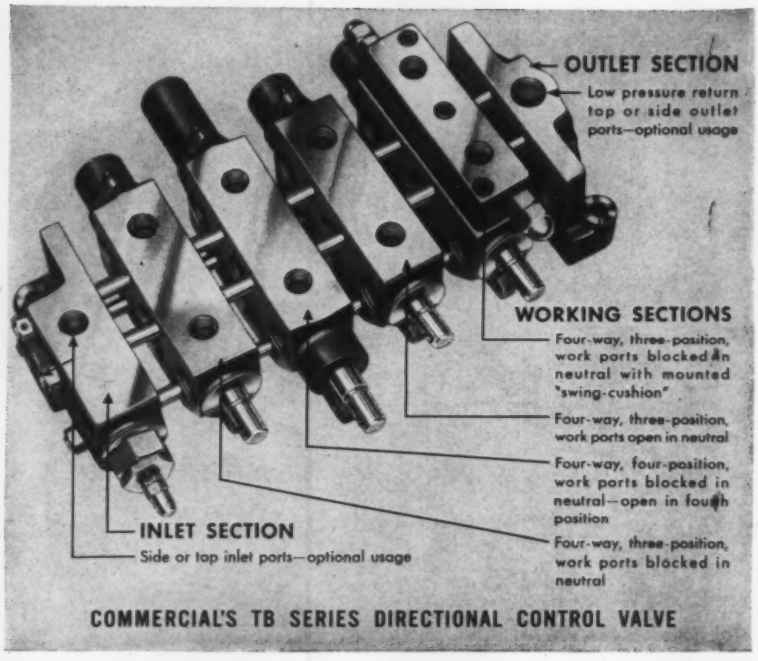
ANOTHER ENGINEERING FIRST FROM

Don't Miss It at the ASTE Show, May 1-8, Booth 1423

Circle 467 on Page 19

(Advertisement)

NEW DESIGN IN FLUID POWER CONTROL VALVES


OUTLET SECTION
Low pressure return top or side outlet ports—optional usage
WORKING SECTIONS
Four-way, three-position, work ports blocked in neutral with mounted "swing-cushion"
Four-way, three-position, work ports open in neutral
Four-way, four-position, work ports blocked in neutral—open in fourth position
Four-way, three-position, work ports blocked in neutral
INLET SECTION
Side or top inlet ports—optional usage
COMMERCIAL'S TB SERIES DIRECTIONAL CONTROL VALVE

Pressure Drop Reduced 15%

The higher the back pressure in a control valve the greater the power loss and the less efficient the fluid power system.

Advance design in Commercial's control valves—larger circulatory passageways, more uniform cross sections, smoother wall surfaces, and freedom from abrupt direction changes—lowers internal pressure drop as much as 15%.

Commercial valve performance is increased because flow around large outside surfaces of solid spools is unimpeded—not forced through constricting orifices. And Commercial's valve passageways have equal or greater cross-sectional area than inlet or work ports.

Load Drop Eliminated

Pressurized return flow in many conventional control valves frequently results in erratic operation—sudden movements and one load dropping while another is being positioned.

An individual check, located so as not to cause any passageway constriction, is built into every working section of a Commercial control valve. It blocks all pressurized return flow until it is overcome by pressure build-up from the pump—makes for safe, smooth, precise and accident-free operation.

2000 PSI Operation Perfected

Because of structural design weaknesses in many control valves optimum operation at pressures up to 2000 psi is often not practical or even possible.

With Commercial's control valves operation at pressures up to 2000 psi is recommended. The non-porous grain structure of the high-strength, semi-steel castings used in Commercial's valve sections prevents seepage of pressurized oil. And because of their greater strength the section castings do not distort when stressed under pressure.

and at the ends of spools assures leak-proof operation. Elimination of gaskets between sections also precludes overstress and distortion of section castings to prevent possible leakage.

Overload Protection Built In

A combination overload relief-pressure valve—incorporated right in the housing of Commercial's control valves—provides positive safety protection for the fluid power system, plus overload protection for the structural members and tools of the machine in operation. Its complete cartridge construction permits easy removal from the inlet section of the valve bank—for quick inspection or replacement.

Rated on Performance

For the purpose of greater accuracy all Commercial control valves are rated on the basis of performance—not mere size of inlet and outlet ports alone. With Commercial's "performance-rated" control valves proper valve selection for any fluid power system is based on total pressure drop values when assembled in various combinations of actual operating actions.

Commercial's control valves involve simultaneously when so desired. Working sections having three-way, three-position; four-way, three-position; and four-way, four-position actions, are available and can be assembled independently in any combination or sequence.

Engineering Help Available

The technical help Commercial sales engineers can offer on the application of Commercial fluid power valves, pumps, motors and cylinders, can easily contribute the kind of fluid power cost savings and improved performance you are looking for and need.

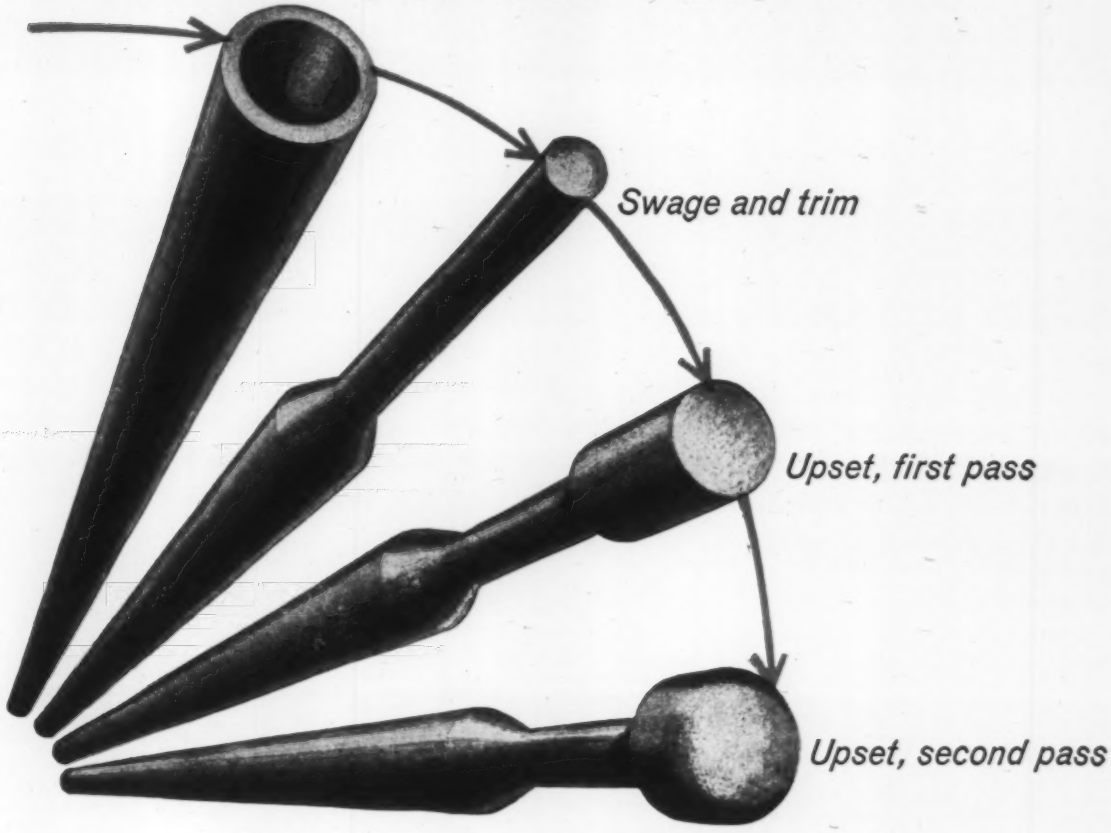
ENGINEERING DATA FREE

For more information write to Dept. S-14, Commercial Shearing and Stamping Company, Youngstown 1, Ohio. For your copies of Commercial's fluid power engineering bulletins just check the items below in which you are interested and attach to your letterhead.

- ☐ "Performance Rated" Valves, Catalog H-12
- ☐ Oil-Hydraulic Pumps and Motors, Catalog H-4
- ☐ Oil-Hydraulic Cylinders, Catalog H-3

COMMERCIAL
shearing and stamping

Start with OSTUCO TUBING



and end up with a 34% *saving*

Here's a cost-cutting case history right in the Ohio Seamless mill. It proves we take our own medicine—*and like it.* You may, too.

Formerly, mandrels for rolling Ostuco Tubing on our Assel mill were made from two pieces. A shaped end, hogged out of solid bar stock, was welded to a long tube. Expensive to machine, weld and process.

We decided to *forge the mandrels entirely from Ostuco Seamless Steel Tubing.* In three steps—swage, upset and finish-form—we now produce better mandrels . . . ready for use without any machining whatsoever, *and save 34% over former processing methods.*

Chances are good that Ostuco Tubing is the right prescription for slashing your production costs, too. For expert advice, contact our nearest sales office or our plant at *Shelby, Ohio—Birthplace of the Seamless Steel Tube Industry in America.*

AA-7225

Visit us at Booth 771—Design Engineering Show Chicago—April 14-17

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OHIO SEAMLESS TUBE DIVISION

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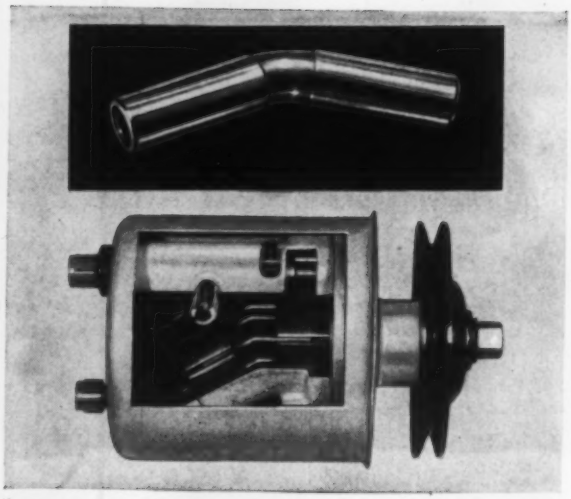
Seamless and Electric Resistance Welded Steel Tubing • Fabricating and Forging

...Flange it!
Flare it!
Bend it!
Expand it!

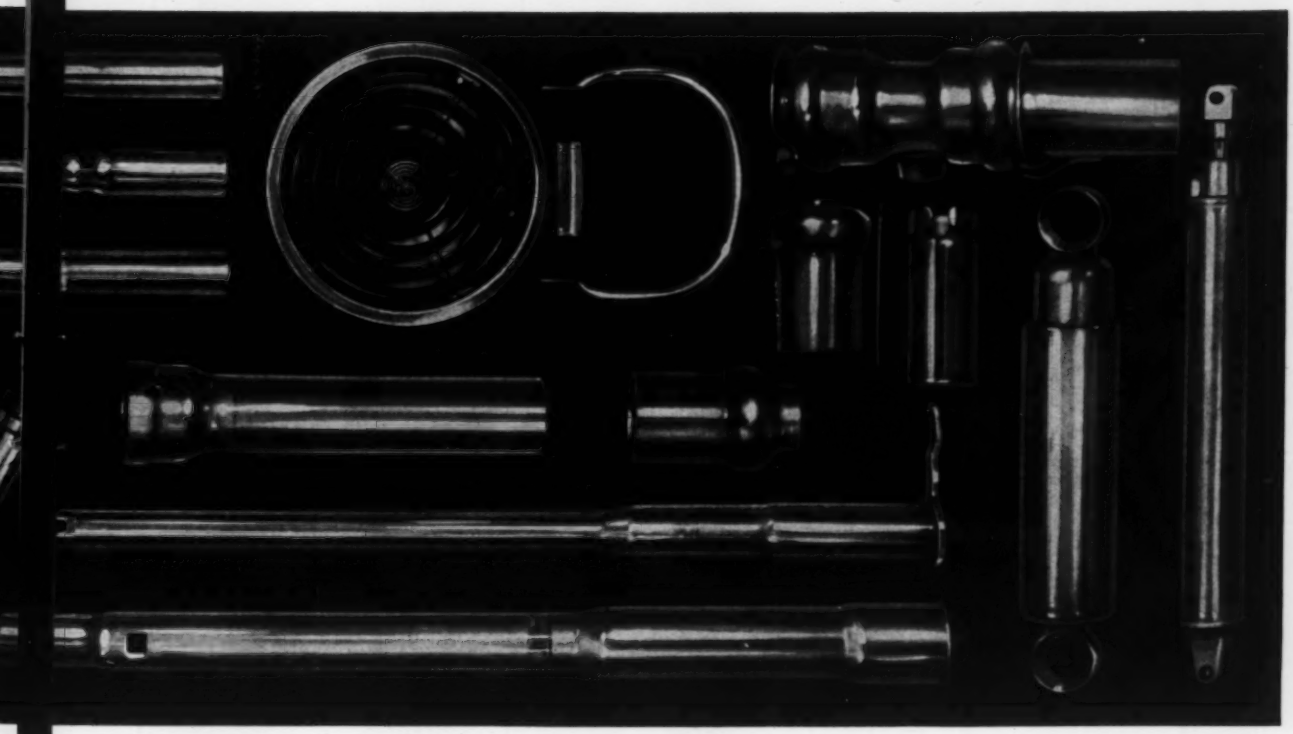
Republic ELECTRUNITE

RANGE BURNER MANUFACTURER STEPS OUT with Republic ELECTRUNITE Mechanical Tubing. Harper-Wyman Company uses it in forming lightweight, easy-to-clean venturi burner tubes. The company subjects ELECTRUNITE to a hairpin bend of 1¼ diameter radius, then a four-way crimp, followed by punching, notching, and welding. Uniform, predictable ductility avoids stretch and collapse as tubing is severely bent and formed. Republic engineers will help you design ELECTRUNITE into your product to speed production, cut costs, and improve performance. Mail the coupon for facts. Or call your Republic representative.



WHEN IT'S MOVING . . . MAKE IT TUBING

Republic ELECTRUNITE meets all close tolerance requirements for new Thompson Products automotive pump. Close tolerance, uniformity, ductility, workability — four important performance requirements, all reasons why Republic ELECTRUNITE Mechanical Tubing is used in a new automotive hydraulic power pump assembly. This pump furnishes power for power steering featured by a nationally famous automobile manufacturer. Will-O-Hill Industries, Inc., Willoughby, Ohio, sub-contractor, manufacturers and specialists in close tolerance tubular stampings, cut 7/16-inch diameter ELECTRUNITE into units 2 3/16 inches long. Each unit is rolled to form a slight groove in the center and bent to an angle of exactly 150°. Nine such pieces are used in each pump assembly. For additional information, send coupon or write today.



Mechanical Tubing

fabricates easily . . . economically . . . with uniformity

Quality makes the big difference!

Republic ELECTRUNITE® Mechanical Tubing is quality-controlled from ore to finished product; produced from highest quality flat-rolled open-hearth steel made in Republic's own mills; carefully inspected to Republic's rigid requirements. Republic Tubing is welded by the exclusive ELECTRUNITE process—a continuous electric weld method that unites the wall under pressure without the addition of foreign or extra metal. Tests prove the ELECTRUNITE weld is as strong or stronger than the original base metal.

Among other advantages, this process assures uniformity of wall thickness, strength, ductility, concentricity, diameter, and physical and mechanical properties. And as the world's largest producer of specialty welded tubing, Republic has the facilities, abilities, and equipment to tailor the tube to your end use. Republic also offers complete tube fabricating facilities.

Let Republic engineers help you select the most economical ELECTRUNITE Tubing to meet your severe processing needs. Call your Republic representative or write today.

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- ☐ Republic ELECTRUNITE Mechanical Tubing
- ☐ Fabricating Facilities
- ☐ Please have a Republic Engineer call

Name_____ Title_____

Firm_____

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City_____ Zone____ State_____

Circle 470 on Page 19

PROOF OF EXTRA SAFETY...

ONLY GREER ACCUMULATORS MEET ALL SAFETY CODES!

Qualify for any type hydraulic installation under all safety ordinances everywnere because... they're

BURST-PROOF!

Design engineers using hydraulic accumulators on machines and equipment in interstate commerce must be aware of stringent nation-wide safety regulations. For guaranteed acceptance everywhere, specify the Greer Accumulator — the only accumulator that meets all safety codes. More than 81,000 Greer Accumulators are now in use in every state of the union and in almost every industry. These exclusive built in safety features tell you why:

AIR VALVE Absolutely leak-proof for pressures up to 12,000 psi. Integrally molded one-piece valve stem prevents gas loss.

SHELL No seams. No welds. No joints. Made of single-piece homogenous chrome molybdenum steel. 18% elongation in two inches guarantees against metal fatigue. 5 to 1 safety margin above maximum working pressure of the accumulator.

MOUTH Designed to yield at 400% of maximum working pressure. This safety feature releases pressure if relief valve clogs or sticks, or if system is blocked.

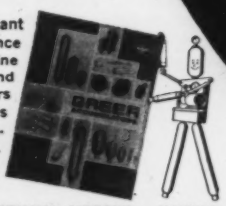
PLUG ASSEMBLY Accumulator cannot be disassembled until complete gas charge in bag has been released. Lack of this safety feature has caused serious accidents. Be sure to check this protection.

Greer Accumulators meet all J.I.C. and I.C.C. safety standards including the strict Penn. Boiler code, and conform with all municipal, state and insurance underwriters safety codes in accordance with ASME specifications on unfired pressure vessels.

Learn more about Greer Accumulators and how they can cut costs on your hydraulic equipment. Contact the franchised Greer distributor in Buffalo, Cleveland, Houston, Philadelphia and Pittsburgh. Inquiries invited from distributors in other areas.

WRITE OR PHONE FOR GREER BULLETIN PR-200

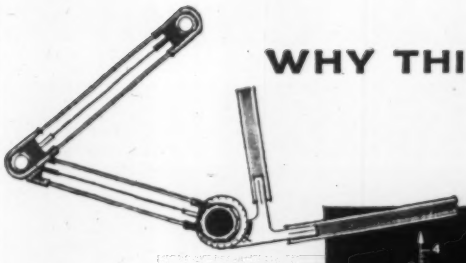
An important catalog reference on the complete line of Greer standard and special accumulators with circuit diagrams and applications. Also details on hydraulic components made by Greer such as valves, filters, actuators, etc.



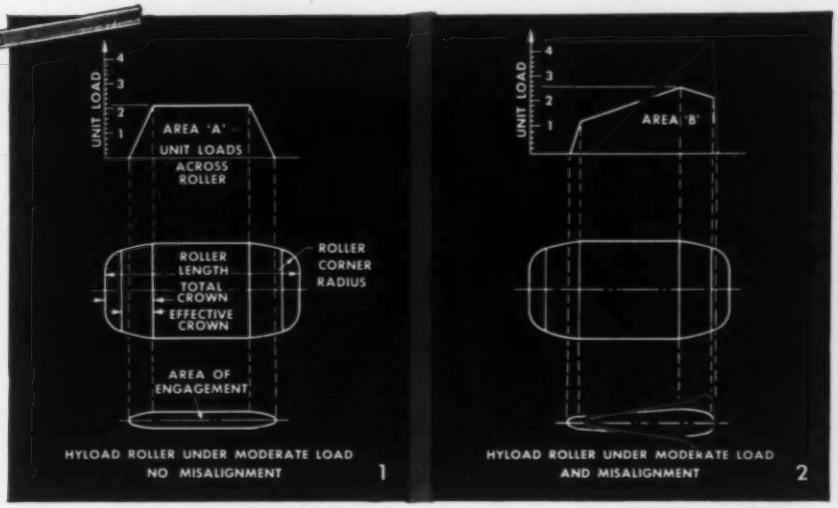
U. S. PATENTS UNDER OLAER LICENSES

GREER HYDRAULICS INC. • INTERNATIONAL AIRPORT • JAMAICA 30, NEW YORK

Manufacturers of Precision Test Equipment and Hydraulic Components



WHY THINGS RUN SMOOTHER WHEN YOU SPECIFY HYATTS

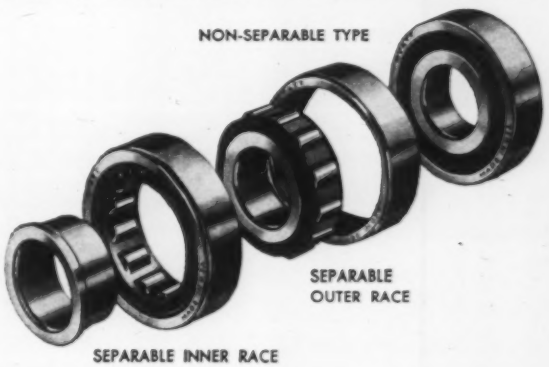


HY-LOAD ROLLER CROWNING MINIMIZES EFFECTS OF MISALIGNMENT—LENGTHENS BEARING LIFE

In any roller bearing, the design and quality of the rollers themselves vitally affect the performance of the entire bearing. The distribution of the load across the roller's full area of contact must be carefully controlled. End-loading and conditions of misalignment can seriously reduce the life of a roller bearing. How HYATT minimizes these effects is detailed at the right.

You will find full selection and application data in HYATT Catalog 150, or call your nearest HYATT Sales Engineer. Hyatt Bearings Division, General Motors Corporation, Harrison, N.J., Pittsburgh, Detroit, Chicago and Oakland, California

The unit load on any roller is distributed axially in a uniform manner except at the ends where crowning has been provided. Figure 1 shows how the unit load drops off to zero at the ends of the area of contact. The summation of unit loads represented by area "A" is the total roller load. This same load under conditions of misalignment (Figure 2) must result in an area "B" equal to area "A"; but the maximum unit load is considerably greater and the misaligned bearing will therefore have a shorter life. However, if the same total load is applied to an uncrowned roller in a misaligned bearing, as shown in red, a much higher maximum unit load (area "C") results, and would reduce the life of the bearing. This demonstrates why HYATT Hy-Load Series Bearings with roller crowning run smoother and longer even under conditions of misalignment.

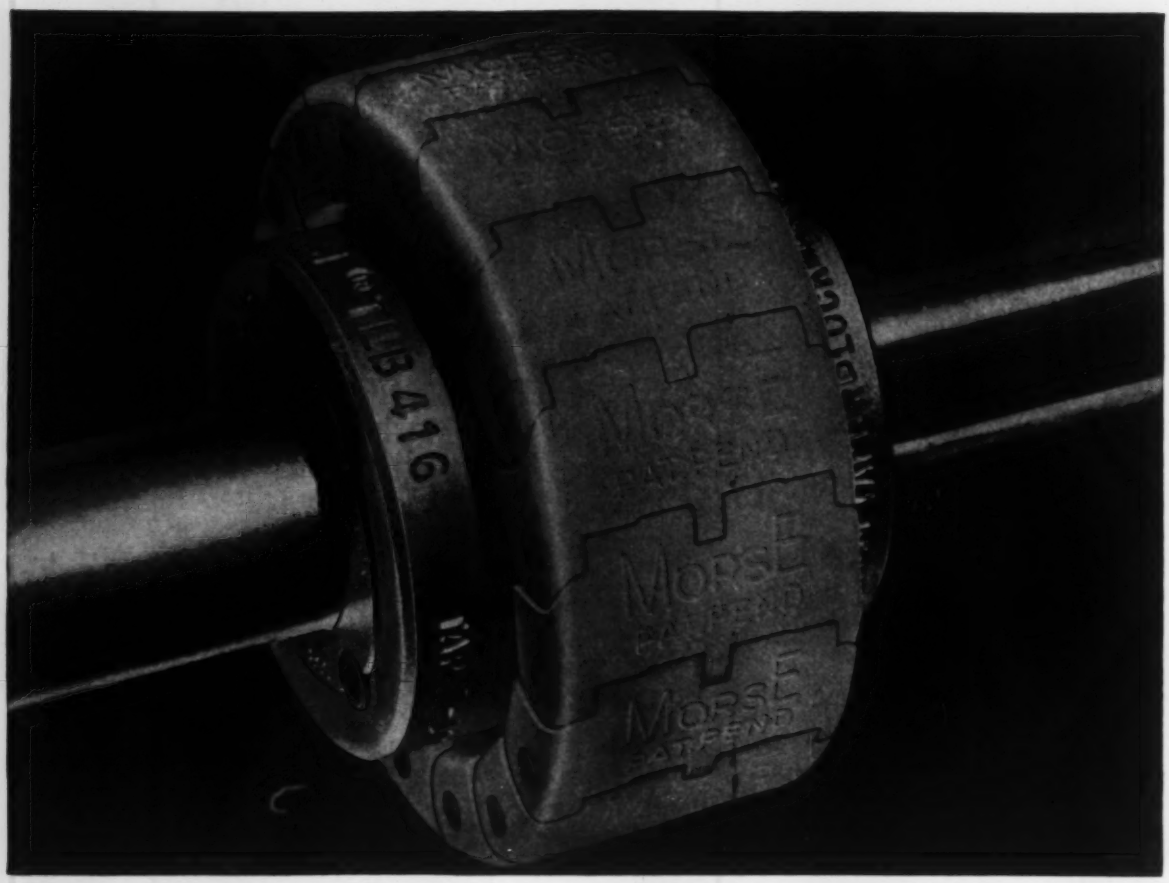


THE RECOGNIZED LEADER IN CYLINDRICAL BEARINGS

GM GENERAL MOTORS

HYATT HY-ROLL BEARINGS FOR MODERN INDUSTRY

Now...from Morse Chain



New Nylon Couplings

Cost 20% less, need no lubrication, last indefinitely!

New Morse Nylon Flexible Couplings cost less to buy and maintain than steel couplings. They use economical, stock roller chain sprockets—need no protective cover. They last longer, too . . . operate without lubrication because friction and wear are negligible.

Order complete couplings—½" pitch links plus stock sprockets (plain, finished bore, or taper-lock)—or buy just the links and use your own sprockets. Morse Nylon Couplings, made of Du Pont "Zytel" resin, are ideal for loads from fractional to 40 h.p. and speeds from 500 to 5000 rpm. And they adjust to misalignment.

For facts on Nylon Couplings, or the other couplings in the most complete line ever offered, call your local Morse Distributor. He's listed in the Yellow Pages under "Power Transmission". Or write: MORSE CHAIN COMPANY, DEPT. 6-48, ITHACA, NEW YORK. Export Sales: Borg-Warner International, Chicago 3, Illinois.

IN POWER TRANSMISSION
THE TOUGH JOBS COME TO

MORSE BW *Trademark

REMEMBER: Only Morse offers all four flexible couplings: Chain, Morflex and Radial, Morflex and Radial Driveshafts, and Nylon

Visit Morse at the Design Engineering Show in Chicago, April 14-17, Booth 945-949

Circle 473 on Page 19

2 NEW EXAMPLES OF HOW DU PONT ELASTOMERS IMPROVE WIRE AND CABLE

1 HYPALON®-*jacketed ignition wire* is now being used by a leading truck manufacturer and is providing new performance standards. With engines becoming more compact and reaching higher temperatures in confined areas, improved heat resistance is required of the ignition wire jacket. But HYPALON withstands heat and ozone even under strain. It resists attack by oil, grease, weathering and many chemicals. It's also exceptionally abrasion resistant.

2 *A neoprene female plug* is a new feature on a heater cord. Reported by its manufacturer to be the first listed by Underwriters Laboratories, Inc., the one-piece molded neoprene plug won't shatter, chip or break even if dropped on the floor or stepped on. It has no screws or rivets. Molded-in contacts won't push back, come loose or turn. The strain relief cord guard is an integral part of the plug. The plug and cord guard are molded to #18 or #16 type HPN neoprene-insulated cord.

Neoprene's resistance to heat, ozone, abrasion and oil makes it the logical elastomer for this cord and plug.

ELASTOMERS IN ACTION HYPALON® • NEOPRENE

DU PONT
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ELASTOMERS

Better Things for Better Living
. . . through Chemistry

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☐ Please send a free copy of *THE DU PONT ELASTOMERS.*
☐ I'd like to know more about using these elastomers for _____

Name _____ *Title* _____
Firm _____
Address _____
City _____ *State* _____

Circle 474 on Page 19

Titanium's corrosion resistance and low heat conductivity team up to...

DOUBLE SOLDERING PRODUCTION

All-titanium *dip soldering jig developed and used by Astatic Corporation has advantage of low heat conductivity and corrosion resistance.*

Titanium *jig has excellent wear resistance, permits holding close tolerances when soldering phonograph needle assembly.*

In handling a variety of soldering operations on small precision parts, Astatic Corporation—electronics manufacturer—has realized many benefits with Mallory-Sharon commercially pure titanium soldering fixtures:

- Corrosion resistance of the titanium fixtures to certain soldering fluxes is excellent. Thus service life is far longer than that of other metals previously used.
- Heat conductivity of titanium is low. Thus the fixture does not take heat away from the work, and the operation takes less time. On a typical assembly, use of the titanium fixture increased daily output from 1000 to 2500 parts per day.
- Titanium's excellent wear resistance, plus the fact that solder does not stick to titanium, allows very close tolerances to be maintained.

Assembly rejects were cut from 25% to less than 1%.

Can *you* use titanium's unique advantages? For information on properties and fabrication techniques ask for the booklet "Titanium Fact File". Write Mallory-Sharon Metals Corporation, Niles, Ohio. Mallory-Sharon produces titanium, zirconium, and other special metals in sheet, strip, rod, bar, plate and other standard shapes to meet your requirements.

Visit us at Booth 284, Design Show, Chicago, April 14-17.

MALLORY-SHARON

METALS CORPORATION • NILES, OHIO

Integrated producer of Titanium • Zirconium • Special Metals

How to do MORE OPERATIONS with drilling machines

by using LIMA *Constant Horsepower* GEARSHIFT DRIVES

THE ORDINARY WAY
STANDARD SINGLE-SPEED MOTOR

1750 RPM INPUT—
OUTPUT SPINDLE
SPEEDS OBTAINABLE
3000
1800
1100
670
400
Recommended Operations
DRILLING

THE LIMA WAY
LIMA GEARSHIFT DRIVE
"FOUR MOTORS IN ONE"

1730 RPM INPUT—
OUTPUT SPINDLE
SPEEDS OBTAINABLE
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Recommended Operations
DRILLING • SPOT FACING • CHAMFERING
COUNTER-BORING • REAMING • TAPPING

LIMA GEARSHIFT DRIVES DELIVER HORSEPOWER AND SPEED WHERE YOU NEED IT!

Lima Gearshift Drives are available to fit drilling machines of the following manufacturers:

Chas. G. Allen Co.
The Avey Drilling Machine Co.
The Buffalo Forge Co.
Champion Blower & Forge Co.
Cincinnati Lathe & Tool Co.
Clausing Div., Atlas Press Co.
Delta Power Tool Div., Rockwell Mfg. Co.
Sibley Machine & Foundry Corp.
Walker-Turner Div., Rockwell Mfg. Co.

Contact your local machinery dealer. He will be glad to have a Lima Drive installed on your new drill press or to supply Lima Gearshift Drives for your present drilling machines—Lima Drives cost only a little more than standard single-speed motors—but they deliver 4 times the operating flexibility.

THE LIMA ELECTRIC MOTOR CO., INC., 4893 **Findlay Road Lima, Ohio**

Representation throughout the U. S., Canada and abroad

LIMA ELECTRIC MOTORS

FIRST . . . FOR DRIVES . . . MOTORS . . . SPEED REDUCERS

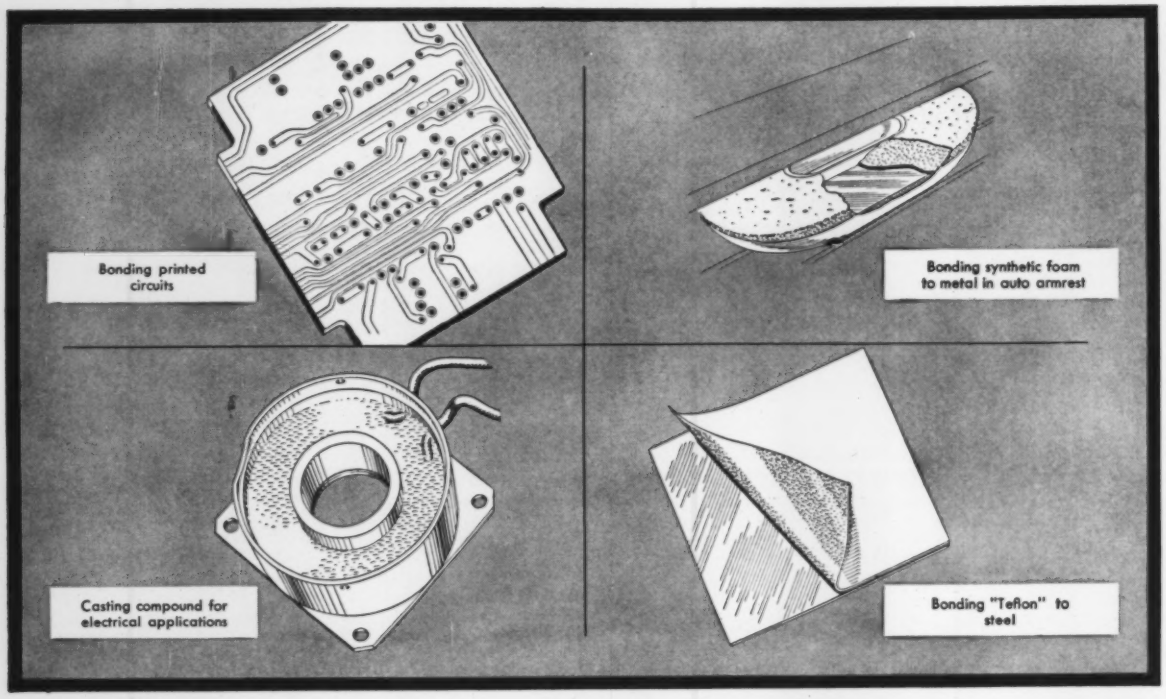
Circle 476 on Page 19

CUT COSTS, IMPROVE DESIGN AND PERFORMANCE WITH R/M PRODUCTS

ADHESIVES

Send for free copy of R/M Bulletin No. 700. Contains full information on Ray-BOND adhesives, protective coatings and sealers.

Adhesives Department, Raybestos-Manhattan, Inc.
Bridgeport, Conn.


Bonding printed circuits
Bonding synthetic foam to metal in auto armrest
Casting compound for electrical applications
Bonding "Teflon" to steel

For these and 1001 other applications —New R/M Ray-BOND Adhesives

The number of new places you can use adhesives today is growing faster than ever. With new bonding techniques and modern Ray-BOND adhesives, you can design reduced fastening time and costs into a variety of applications never before possible.

R/M Ray-BOND adhesives are of two different types—thermosetting and thermoplastic. They are available in different degrees of viscosity—for either spraying or painting. They give top performance under the most severe operating conditions —withstand temperature extremes ranging from –80° to +700°F.

Whether or not you have yet considered bonding, sealing, casting or coating in your own operations, talk to an R/M engineer about new Ray-BOND adhesives. Over 20 years' pioneering in the production of bonded assemblies and the manufacture of adhesives and coatings has given Raybestos-Manhattan a wealth of knowledge and experience that could well help you find new ways to improve your product and cut your production costs.

For special requirements R/M will tailor special adhesives . . . to meet your individual needs.

R/M

Brake Blocks, Linings and Clutch Facings

Mechanical Packings and Gaskets

Abrasive and Diamond Wheels

Industrial Drive Belts

Industrial and Automotive Hose

Conveyor Belts

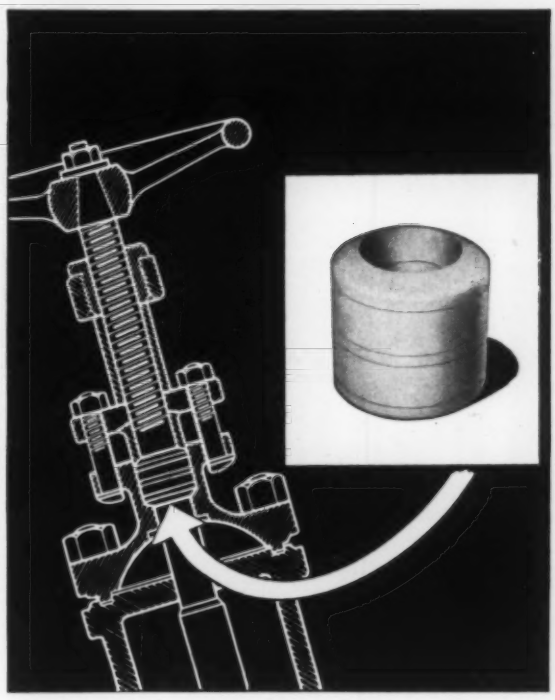
SPECIALISTS IN ASBESTOS, RUBBER, SINTERED METAL, ENGINEERED PLASTICS

PACKINGS

Complete information on packings shown and many others is given in free booklet. Send for it today.
Packing Division, Raybestos-Manhattan, Inc.
Passaic, N.J.

RUBBER

Write today for free booklet shown: full details on a wide variety of industrial rubber products.
Manhattan Rubber Division, Raybestos-Manhattan, Inc.
Passaic, N.J.



R/M Valve Stem Packings are available in many formulations for varied needs.

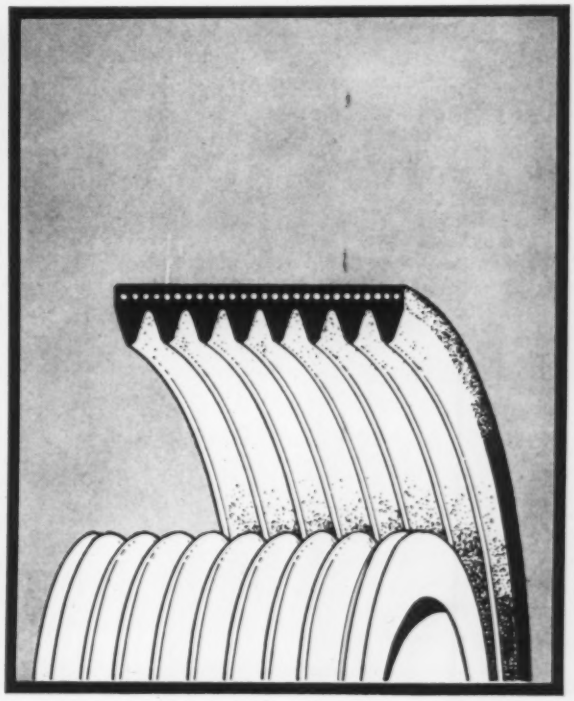
Close fit, long wear with R/M valve stem packings

You get the benefit of R/M's long experience as a leader in the packing industry when you select valve stem packings made by Raybestos-Manhattan. R/M engineers, working in superb laboratories, have perfected or can perfect packings to meet your most exacting requirements, whether you are coping with extremes of temperature, extremes of pressure, or corrosive materials.

Corrosive materials, for example, do not harm R/M "Teflon"* valve stem packings. These packings, supplied in wedge type, angular type, and solid unit rings, are ideal for all kinds of valve stems. They will give you outstanding performance in equipment handling acids, alkalies or solvents. They are recommended for slow-moving reciprocating rods on measuring and blending equipment.

Whatever your packing needs, feel free to call on R/M.

*A Du Pont trademark



R/M Poly-V Drive, more power—less space

No other belt drive delivers as *much* power in as *little* space as R/M's patented Poly-V* Drive. Poly-V's single, endless parallel V-ribbed belt runs on grooved sheaves to mate precisely with belt ribs . . . gives the drive *twice* the tractive surface to deliver up to 50% more power in the same space as a V-belt drive—or equal power in as little as ⅔ the space! This means less shaft overhang . . . a more compact, lighter drive. Single unit design eliminates belt matching problems, helps maintain constant pitch diameter and speed ratios from *no* load to *full* load. Just two cross sections of Poly-V Belt meet *every* heavy duty drive design requirement!

R/M specialists will work with you wherever you need Poly-V Drives, flat transmission or V-belt drives, conveyor belts, hose, molded or other rubber products.

*Poly-V is a registered Raybestos-Manhattan trademark.

RAYBESTOS-MANHATTAN, INC.

FACTORIES: Passaic, N.J. • Bridgeport, Conn. • Manheim, Pa. • Paramount, Calif. • No. Charleston, S.C. Crawfordsville, Ind. • Neenah, Wis. • Peterborough, Ontario, Canada

Rubber Lined and Covered Equipment

Sintered Metal Friction Elements

Asbestos Textiles

Industrial Adhesives

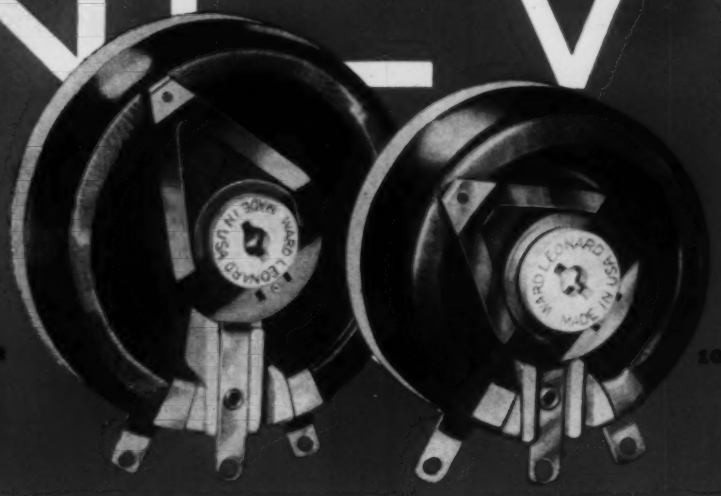
Teflon Tape, Packings, Sheets, Rods, Tubes

Engineered Molded Rubber and Plastics

RM

Circle 477 on Page 19

NEW



SMOOTH-PERFORMING RING RHEOSTATS

New 100- and 150-watt sizes incorporate latest design improvements

ENGINEERING DATA

Type	Rating*	Ring Diameter	Max. Depth behind panel	Resistance Range (Stock Values)	Rotational Travel
100R	100 Watts	3 5/32"	1½"	1 to 10,000 ohms	300°
150R	150 Watts	4"	1¾"	1 to 10,000 ohms	314°

*—Ratings based on a 300°C rise in a 40°C ambient.

Contact Shoe: "Twin" metal graphite, equipped with integral copper leaf conductor ribbon riveted to the control arm.

Contact Arm: Balanced beryllium copper, locked directly to insulating hub.

Base and Core: High-grade ceramic of high dielectric strength with toroidally wound resistance wire or ribbon of highest stability.

Max. Voltage Spacings: 300 volts in accordance with Underwriters' Laboratories requirements.

Naturally, these new 100- and 150-watt ring rheostats give you the same outstanding, proved design features you get in 25-, 50-, and 300-watt sizes. Exclusive "twin-contact" shoes insure uniform contact resistance, extra-smooth resistance change. Two sintered, self-lubricating contacts—one on the collector ring and one on the resistance winding—can't gall or seize like metal-to-metal contacts. They insure long, stable operating life under rated loads.

Ward Leonard Vitrohm vitreous enamel permanently bonds base and core, firmly secures the high-stability resistance wire. Base and core are of high-density, low-porosity molded ceramic of high dielectric strength.

A new ceramic hub design substantially eliminates backlash. It also makes for fast delivery on special shaft requirements.

Write for Ward Leonard Bulletin 60RR. It gives complete specifications on 25-, 50-, 100-, 150-, and 300-watt ring rheostats. Ward Leonard Electric Company, 58 South Street, Mount Vernon, New York. (In Canada: Ward Leonard of Canada, Ltd., Toronto.) e.s

LIVE BETTER...*Electrically*

WARD LEONARD ELECTRIC COMPANY
MOUNT VERNON, NEW YORK

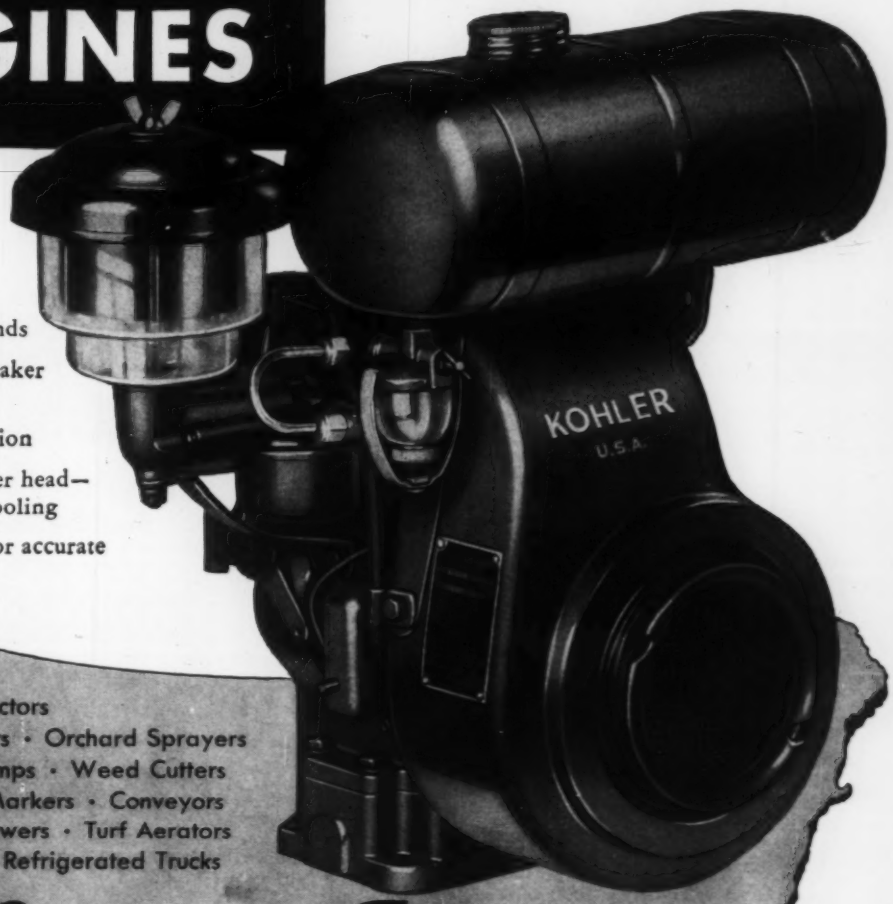
Result-Engineered Controls Since 1892

KOHLER ENGINES

4-CYCLE SHORT-STROKE AIR-COOLED

MODEL
K90

- Balanced crankshaft—ball bearings at both ends
- Externally mounted breaker points
- Positive splash lubrication
- Aluminum alloy cylinder head—deep fins for efficient cooling
- Mechanical governor for accurate RPM control



Riding Tractors
Rotary Tillers • Orchard Sprayers
Centrifugal Pumps • Weed Cutters
Highway Line Markers • Conveyors
Riding Lawn Mowers • Turf Aerators
Snow Blowers • Refrigerated Trucks

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Lawn Rollers • Cultivators • Grain Blowers • Milkers • Grain Elevators
Disc Grinders • Pump Jacks • Portable Saws • Sprayers • Motor Bikes
Hoists • Floor Sweepers • Augers • Air Compressors
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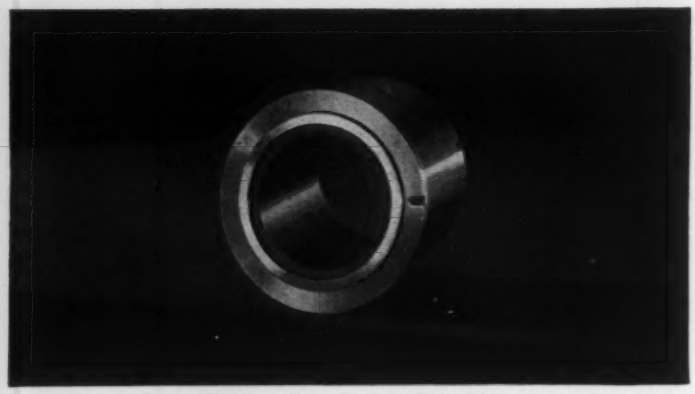
KOHLER OF KOHLER

Enameled Iron and Vitreous China Plumbing Fixtures • Brass Fittings • Electric Plants • Air-cooled Engines • Precision Controls

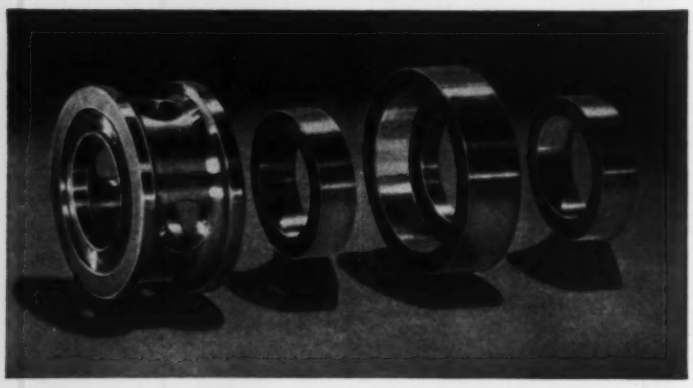
Circle 479 on Page 19



SINGLE BUSHING TYPE Floating Ring Seal

Seal Any Medium—Even Corrosive Media ... with Koppers Floating Ring Seal

MULTIPLE RING TYPE Floating Ring Seal (assembled)



FLOATING RING SEAL Basic Elements: Lantern Ring, Floating Ring, and Spacer Diaphragm. As sealing needs dictate, floating rings and spacer diaphragms are added. Seals are carbon, plastics, ceramics or steel, as applications require.

The Only "No Maintenance" Seal for Rotating, Oscillating and Reciprocating Motion

Koppers' precise, efficient Floating Ring Seal assures long seal life, low leakage, reduced wear, less power consumption, and decreased operating costs.

It seals at high temperatures and at pressures up to, and for some conditions even above, 2000 psi. Inspection has shown that after 10,000 hours of operation, ring and spindle wear can be negligible. For water at 500° F. and 1200 psig with a 5/8" spindle, leakage is only one to two pounds per hour. Frictional power requirements are virtually zero, and Koppers' design reduces radial frictional restraint. Sealing members adapt to changes in the shaft's position.

Applicable to valve spindles, pumps, atomic reactor spindles and many other similar installations, Koppers Floating Ring Seal gives efficient, low-cost service for the sealing of all types of fluids under widely varying conditions of temperature and pressure.

For additional information, write to: KOPPERS COMPANY, INC., Piston Ring and Seal Department, 2304 Hamburg Street, Baltimore 3, Maryland.

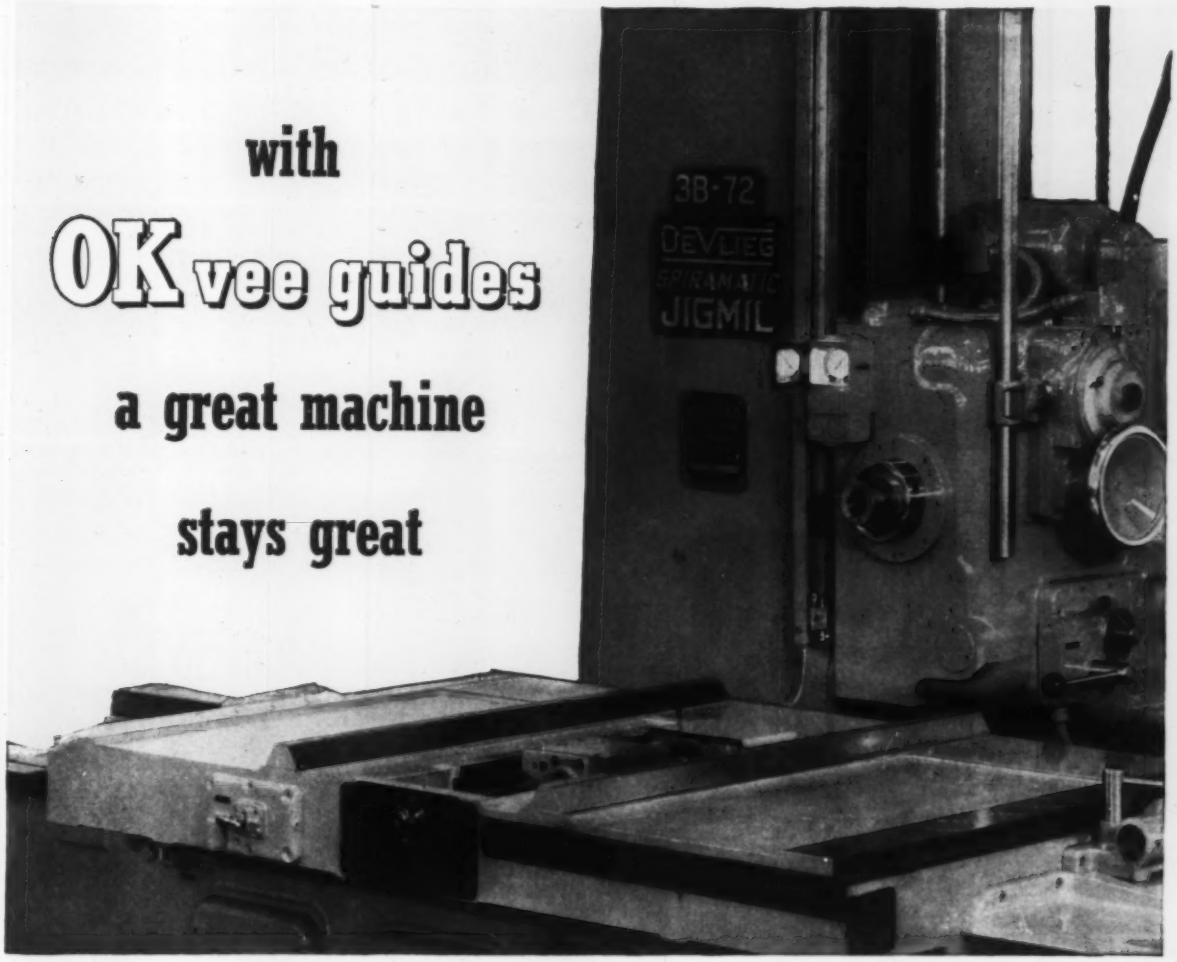
KOPPERS

MECHANICAL SHAFT SEALS

Engineered Products sold with *Service*

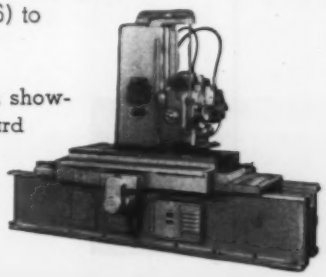
Circle 480 on Page 19

with OK vee guides a great machine stays great



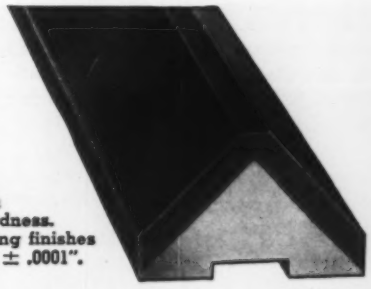
THE DeVLIEG MACHINE CO. has been a consistent user of OK Hardened Products for many years. They build absolute precision into their line of boring and milling machines. One of the methods of achieving this ultra-precision throughout the life of their machines is with OK hardened vee guides as illustrated in this exposed photo of their Spiramatic Jigmil.

Here's why OK hardened vee guides contribute to machine tool accuracy: They are virtually wear-proof, a result of welding special analysis tool steel to a mild steel backing. High wear-resistant properties are produced by special hardening (Rockwell C-65-66) to a depth of 3/16"



For Free bulletin, showing seven standard cross sections in over 60 sizes, write Dept. 45-A

At Booth 456—Design Engineering Show

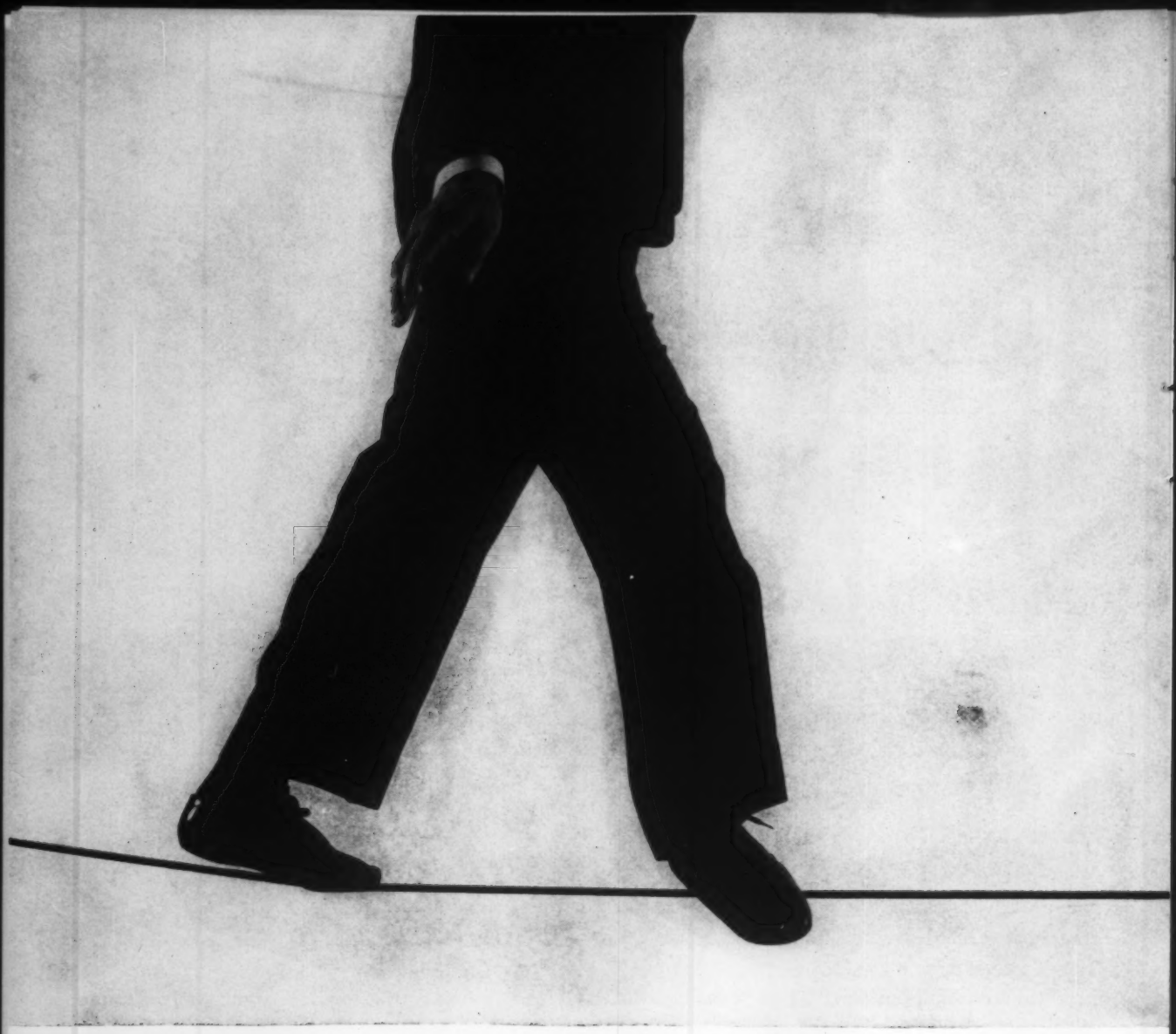


Cross section illustrates depth and area of hardness. Precision grinding finishes to tolerances of ± .0001".

Hardened Ways • Slitter Knives • Shear Blades
Cut-off Blades • Hardened Spacers • Gibs • Ball Races
Work-rest Blades • Wear Strips • Bronze Ways

THE OHIO KNIFE CO.

CINCINNATI 23, OHIO



Strength—On an island off the coast of Greenland, you can find the remnants of three large meteorites which the Eskimos have named "The Tent," "The Woman" and "The Dog." Only about one half of the meteorite mass remains, because native warriors and craftsmen worked for untold centuries to rip away pieces of the heaven-sent alloy for vital weapons and tools. So it is today, that man first turns to steel when he needs a versatile metal of great strength.

If strength were the only consideration of the designer, his job would be simple: pick the strongest steel he can afford for the job. But invariably, he is enmeshed in a spider's web of other problems. He needs varying amounts of corrosion resistance, toughness, weldability, fatigue or wear resistance, formability. To cap it, he is asked to choose from a vast range of different steels, at different prices, with different combinations of properties. Then come the added complications of heat treating, and the fact that production techniques may have a profound effect on several important properties of the steel he has chosen.

But underlying all this, one fact remains: In theory, there is one best steel for any application. When you know the performance requirements and the cost problems, when you are intimately familiar with all the properties of all the available steels, you can usually settle on one that will result neither in overdesign nor underdesign. And you are almost certain to find that steel in the great family of USS Design Steels, a selection unmatched by any other producer in the world.

For careful design, when cost is a problem, the selection of the best steel should be made by a skilled metallurgist—either on your staff or ours. Write United States Steel, 525 William Penn Place, Pittsburgh 30, Pennsylvania.

United States Steel Corporation • American Steel & Wire • Columbia-Geneva Steel • National Tube
Tennessee Coal & Iron • United States Steel Supply • United States Steel Export Company

USS **United States Steel**

Circle 482 on Page 19

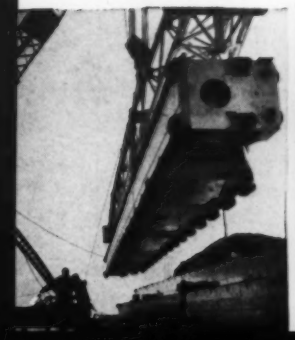
STEELS FOR DESIGN

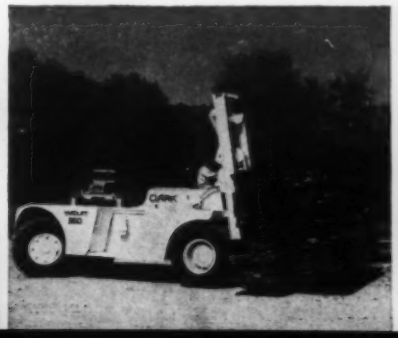
Lower Left—Problem: Several of the stop logs fabricated by Montreal Locomotive Works for the St. Lawrence Seaway's St. Lambert Lock had to be made extra-strong to withstand greater water pressure than typical of the other locks. But to insure ease of handling and interchangeability with the other logs, they couldn't be made larger. Solution: Logs were made of USS MAN-TEN Steel, one of several USS High Strength Steels. Benefit: MAN-TEN logs are much stronger, but have same weight and size as regular stop logs.

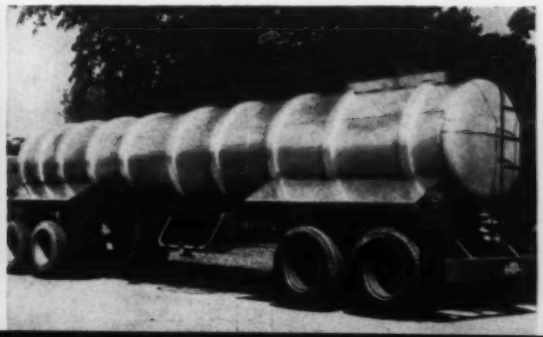
Lower Middle—Problem: On a lift truck, every pound of weight forward of the wheels reduces load capacity. Solution: Clark Equipment Co. designed lift truck carriage assembly from USS "T-1" Constructional Alloy Steel, reducing weight of assembly by 66⅔%, compared to structural carbon steel. Benefit: Pay load was greatly increased, due to USS "T-1" Steel's 90,000 psi yield strength.

Lower Right—Problem: Heil Company wanted to design a very strong, corrosion-resistant tank trailer to haul corrosive solutions. Solution: Using Type 316 USS Stainless Steel, they developed the unusual ribbed design visible in the picture. Benefit: Stainless Steel's strength helped to give greater beam strength to the tanker. Its corrosion resistance allows the tank to be cleaned easily, so it can be used to haul different liquids on different trips.

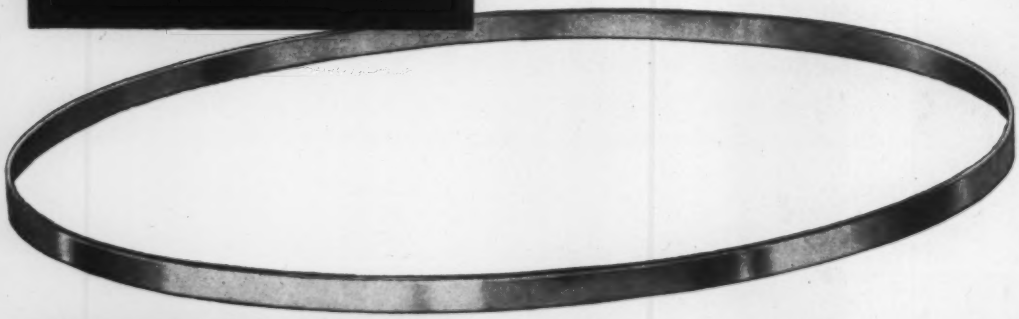
USS, Man-Ten and "T-1" are registered trademarks







Precision Rings with little or no machining



Today you can purchase precision flash butt-welded rings that require little or no machining to meet your specifications. Made from bar stock of finished gauge, they can be produced to meet the same tolerances as conventionally machined rings. Cost of production and materials of some rings has been reduced as much as 60%. Sizes and materials at present are limited to those bar stocks which can be furnished to precise finished dimensions. However, persistent efforts of American Welding engineers and the producers of finished bars give promise of a widening range of sizes and metals that can be manufactured by precision forming and welding.

This is another example of why you should call American Welding first — if the problem is circular and of metal.

New Products Catalog

Write today for 20-page catalog of circular products which American Welding can form, weld and machine for you.

AMERICAN WELDING

THE AMERICAN WELDING & MANUFACTURING CO.
130 DIETZ ROAD • WARREN, OHIO

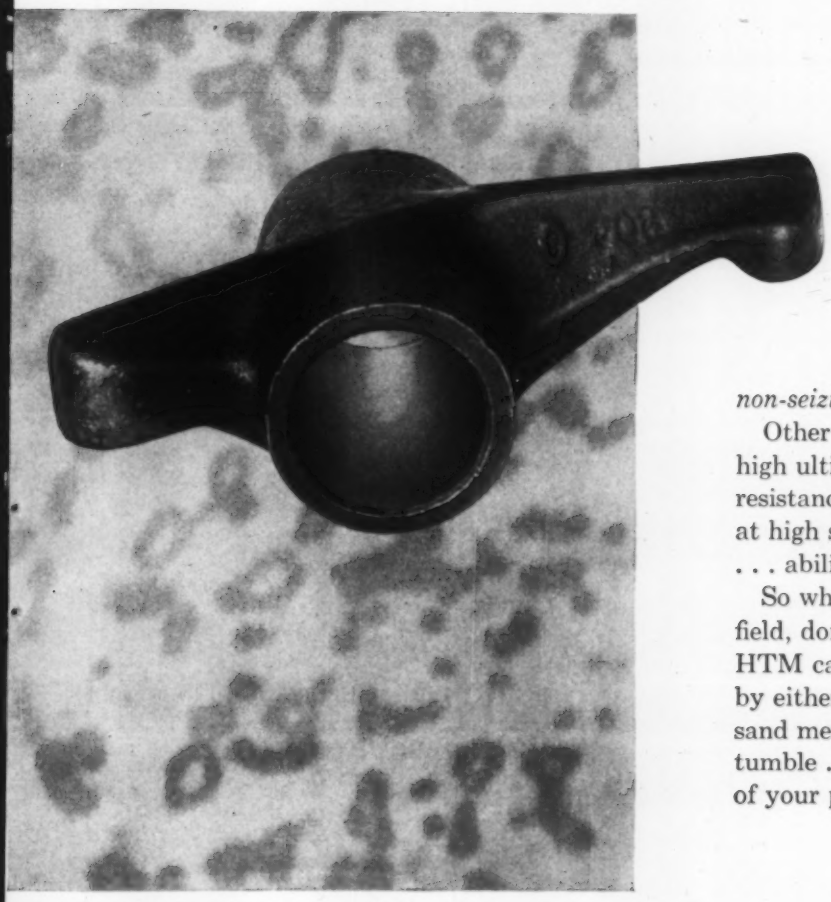
Circle 483 on Page 19

is your problem

bearing surfaces?

NATIONAL HTM CASTINGS

are the answer



Sleeve bearings and bushings are expensive at best. Often they're unsatisfactory, too. May lead to service and lubrication problems. Frequently you can whip these problems at one fell swoop—by specifying HTM (Pearlitic Malleable) castings because of their *excellent, non-seizing bearing properties.*

Other advantages of HTM castings are high ultimate strength . . . extreme wear resistance under heat and heavy loads at high speeds . . . air or liquid quenching . . . ability to be smooth-finished.

So when you're looking over the materials field, don't overlook the advantages of HTM castings. For HTM metal can be cast by either the shell mold, CO_2, or green sand methods. This means production costs tumble . . . performance and saleability of your product go up.

AA-6931

Important Physical Properties	
Brinell	163 to 302*
Yield, psi	48,000 to 85,000*
Ultimate, psi	70,000 to 110,000*
Elongation, %	7 to 2*

*Depending upon grade

NATIONAL MALLEABLE and STEEL CASTINGS COMPANY

Established 1868 *Cleveland 6, Ohio*

The nation's largest independent producer of malleable and pearlitic malleable

Circle 484 on Page 19

SEE this modern LOVEJOY Power Transmission Equipment

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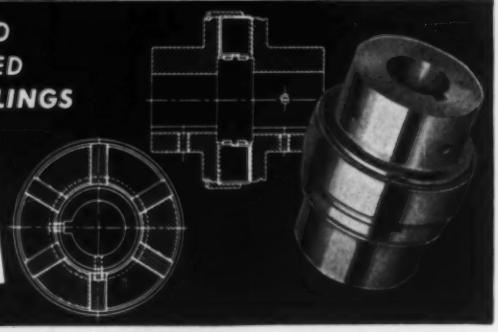
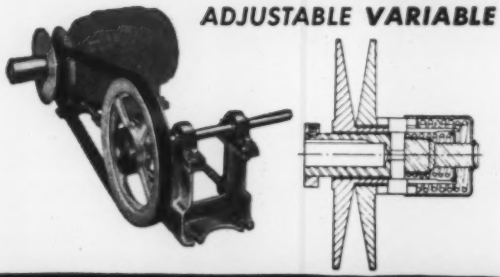


Bores (max.) . . . . . 3/16" to 9 1/2"
O.D. . . . . 5/8" to 21 1/2"
Wt. . . . . 1/2 oz. to 1500 lb.
H.P. . . . . 1/20 to 3000
Torque (static) . . 1 1/2 to 5100 ft.-lbs.

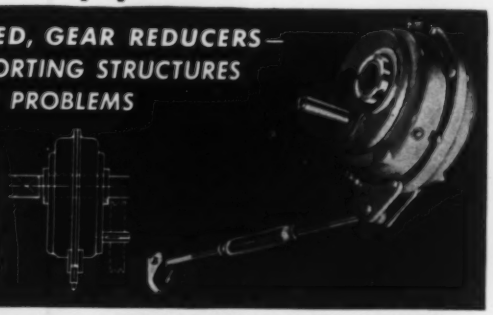
MAINTENANCE-FREE INSTANTLY-ADJUSTABLE VARIABLE SPEED PULLEYS



Bores (max.) . . . . . 1/2" to 1 3/8"
O.D. . . . . 3" to 13 5/8"
Belt Sizes . . . . . A to 2 3/4 TW
Speed Ratios . . . . . 1-1 to 8-1
H.P. (1750 rpm.) . . . . 1/4 to 15

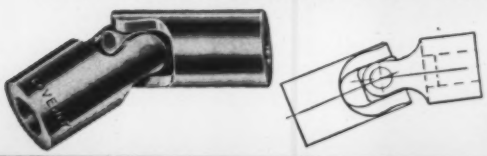
NEW

SHAFT MOUNTED, GEAR REDUCERS— ELIMINATE SUPPORTING STRUCTURES END ALIGNMENT PROBLEMS



18 Models From Stock
Speeds . . . . . 8 to 425 R.P.M.
H.P. . . . . Fractional to 120
Ratios . . Single 4.5:1 Nominal
Double 14.7:1 Nominal
Hollow . . Shafts 1 7/16 to 5 7/16 in.

LIGHT-WEIGHT PRECISION-BUILT UNIVERSAL JOINTS



Bores . . . . . 1/8" to 2"
Hub Dia. . . . . 1/2" to 4"
Static Torque . . . . . 340 to 130700 in.-lbs.
H.P. (100 rpm.) . . . . . 1/2 to 207

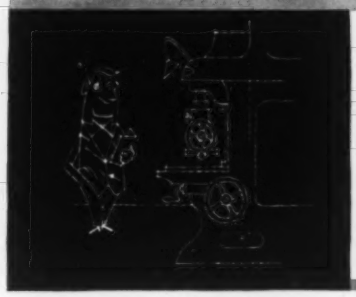
LOVEJOY FLEXIBLE COUPLING COMPANY

4818 WEST LAKE STREET CHICAGO 44, ILLINOIS

TOOLING FOR COMPETITION

1958 ASTE TOOL SHOW AND CONFERENCE

CONVENTION CENTER • PHILADELPHIA, MAY 1-8



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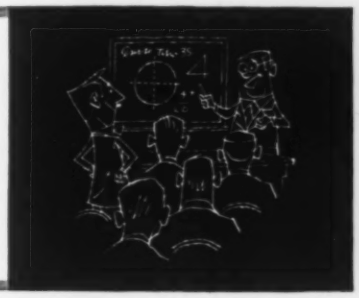
Symposia, panels and technical papers will be devoted to subjects of vital interest to you . . . subjects like: Automation • Metal Cutting • Materials of the Future • Numerical Control • Plastic Tooling • Ceramics • Tool Engineering • Shaped Diamond Tools.



MEET and exchange ideas with management, engineering production, sales people from the nation's leading industrial concerns.

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INSPECT the modern equipment and up-to-the-minute manufacturing methods being utilized in booming Delaware Valley plants.

See industry in action. Inspect such Philadelphia area plants as: Standard Pressed Steel • U.S. Steel • U.S. Navy Yard • Leeds & Northrup • Schramm, Inc. • Chrysler-Plymouth • Yale & Towne • Link-Belt • Budd Company • Brown Instrument.

AMERICAN SOCIETY OF TOOL ENGINEERS

TOOL SHOW CONFERENCE '58 MAY 1 TO 8

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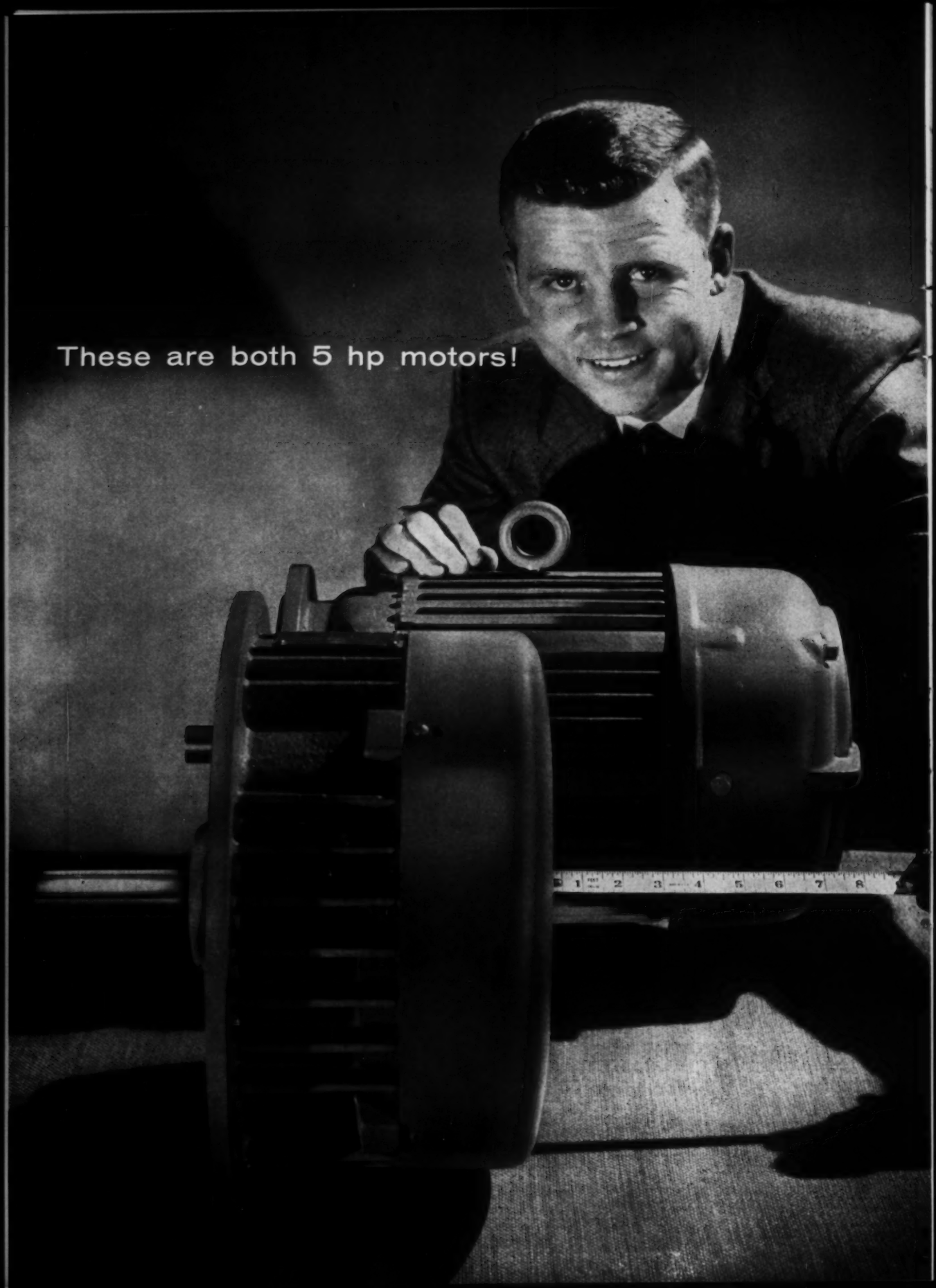
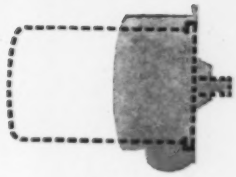
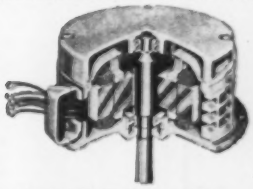

These are both 5 hp motors!



SAME NEMA RATING IN
60% LESS SPACE



PERFORMANCE-PROVED RADIAL
AIR-GAP DEPENDABILITY

New-product news from Louis Allis

60% shorter–
but with radial air-gap design!

New Louis Allis Pancake Motor preserves all the advantages of conventional motor construction

The new Louis Allis Pancake Motor is your solution to trouble-free power in any space-cramped motor application.

The Pancake is a remarkably short flange-mounted motor — up to 60% shorter and 33% lighter than standard motors of the same rating! And it is built in *conventional* radial air-gap design!

It's done by an ingenious forming process which literally compresses the end coils of a conventional radial air-gap motor into an exceptionally short length. The result is a compact, light motor ideally suited for horizontal or vertical mounting on machine tools, roof ventilating fans, or *any* close-quarter installation where space is a critical design factor.

What's more, this is achieved without sacrificing a single desirable characteristic: the stator still contains the same iron and copper as standard Louis Allis motors . . . standard NEMA service factor is maintained . . . high insulative values are retained by using proved Louis Allis varnishes and new insulating techniques . . . over-sized pre-lubricated bearings are used to guarantee long bearing life . . . and the entire motor is enclosed in an industrial-type cast-iron housing designed to shrug off abuse!

The housing and flange are cast in one piece: this permits extra-accurate internal machining which extends bearing life and reduces noise levels to a new low.

Investigate the Pancake Motor through your local Louis Allis District office. Sized from 1 to 15 hp, at 1800, 1200, and 900 rpm, in open drip-proof and enclosed non-ventilated or fan-cooled enclosures. Write for Bulletins 2100 and 2150 to the Louis Allis Co., 459 E. Stewart St., Milwaukee 1, Wisconsin.

MANUFACTURER OF ELECTRIC MOTORS AND ADJUSTABLE SPEED DRIVES

LOUIS ALLIS

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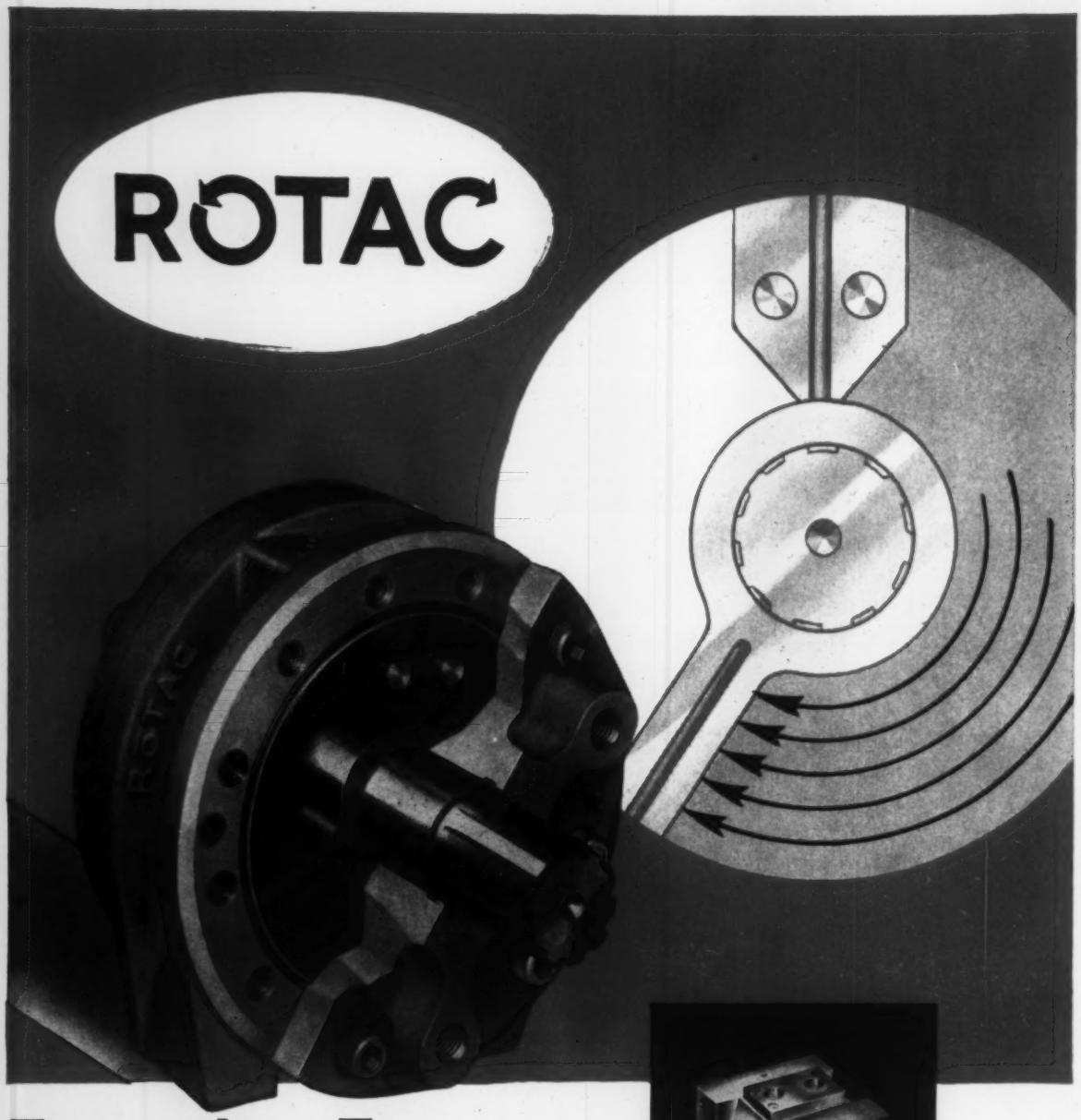
SM-104

RŌTAC



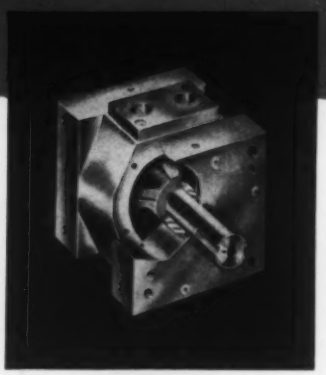
Tremendous Torque in Small Space

If you are at all concerned with an operation involving power transmission, you owe it to yourself to investigate this new name in reciprocating torque actuators: Rōtac.

The name, Rōtac, may be unfamiliar to you because of its very newness—but the name (and reputation) of Ex-Cell-O should excite your interest. Even now, Rōtac reciprocating torque actuators are performing such operations as clamping, indexing, lifting, revolving, lowering, extending, retracting, closing, opening, oscillating and turning, on a wide variety of machinery.

FREE—NEW 20 PAGE BROCHURE

If you move *anything,* then you'll want detailed information on Rōtac. Learn how this rotary power is used throughout industry in thousands of applications. Complete with photos, schematics, engineering data, etc. 57-59



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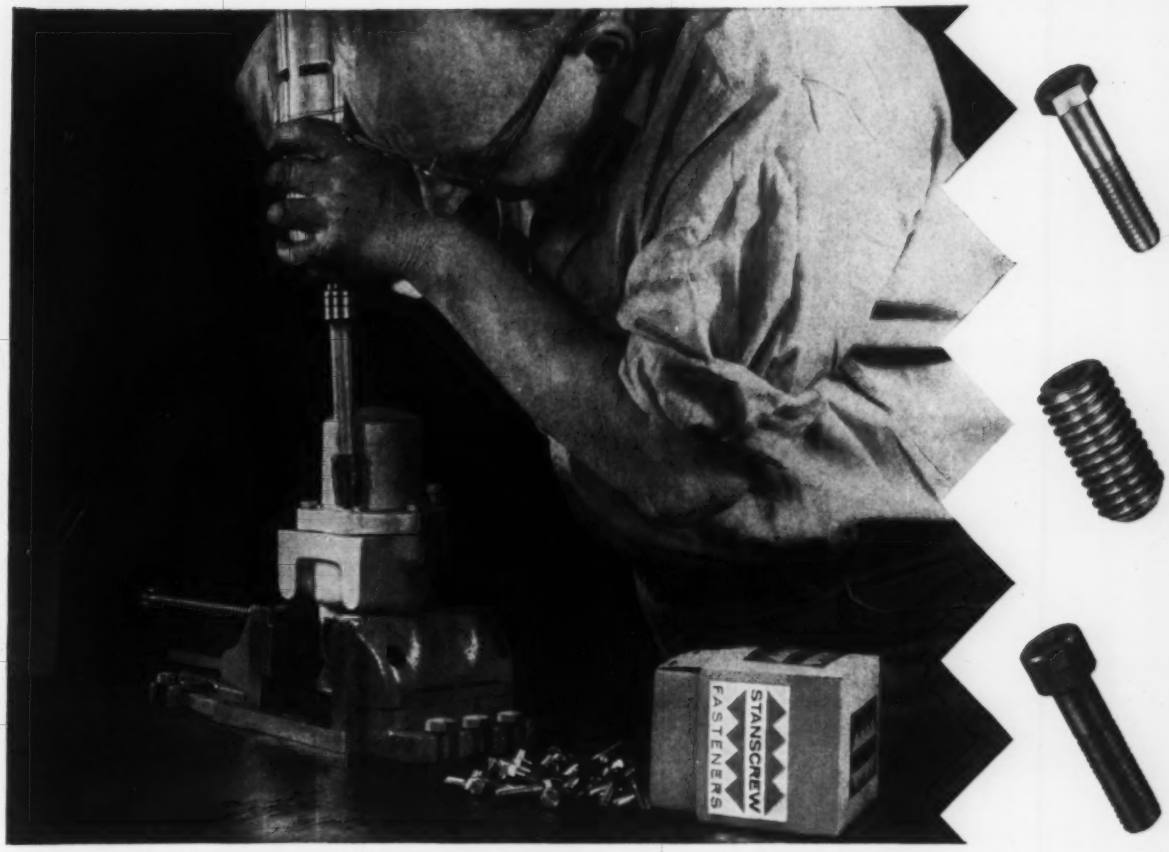
EX-CELL-O CORPORATION

EX-CELL-O PRECISION PRODUCTS INCLUDE: MACHINE TOOLS • GRINDING AND BORING SPINDLES • CUTTING TOOLS • RAILROAD PINS AND BUSHINGS • DRILL JIG BUSHINGS • AIRCRAFT AND MISCELLANEOUS PRODUCTION PARTS • DAIRY EQUIPMENT

IT PAYS TO STANDARDIZE ON **STANSCREW**



Stanscrew service cuts rejects, speeds assembly for valve manufacturer

A prominent manufacturer of 4-way valves for freon was having trouble on his assembly line. His fasteners, tightened to an extreme degree to prevent seepage of the gas, were breaking on too many occasions. This meant complications in assembly and a high reject rate—which increased production costs substantially.

One of Stanscrew's fastener specialists, called in by a Stanscrew distributor, quickly found the answer. He recommended a standard cap screw and had staff engineers work out the precise torque which should be applied to insure a complete seal at all gaskets, yet eliminate any possibility of fastener breakage. By following these recommendations, the manufacturer has eliminated the problem of fastener breakage, and substantially reduced his reject rate.

Stanscrew offers over 4,000 standard fasteners . . . including a complete selection of socket, set, and cap screws. All are produced under rigid quality control methods and incorporate the lessons learned during 85 years of fastener manufacture. All 4,000 are always in stock and quickly available.

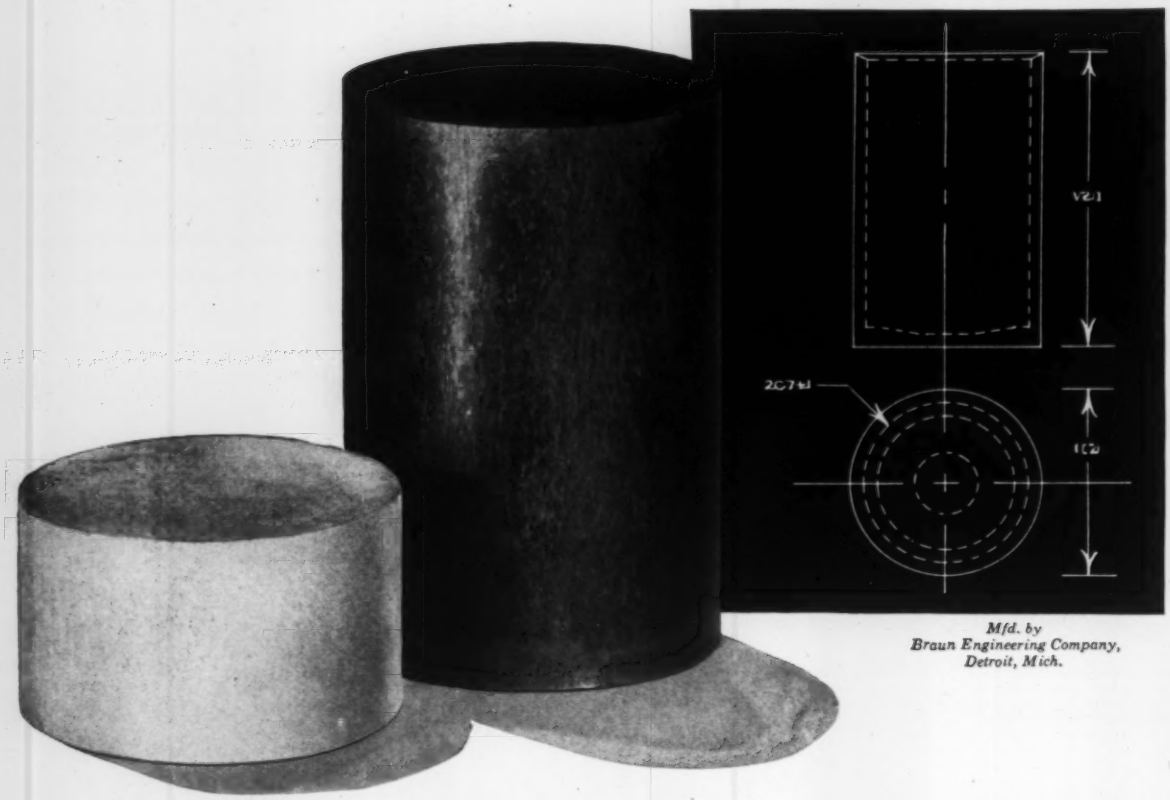
For the answer to your fastener problem, call your Stanscrew distributor. He will have a Stanscrew fastener specialist promptly study your operation and make specific recommendations.

STANSCREW FASTENERS

CHICAGO | THE CHICAGO SCREW COMPANY, BELLWOOD, ILLINOIS
HMS | HARTFORD MACHINE SCREW COMPANY, HARTFORD, CONNECTICUT
WESTERN | THE WESTERN AUTOMATIC MACHINE SCREW COMPANY, ELYRIA, OHIO

STANDARD SCREW COMPANY 2701 Washington Boulevard, Bellwood, Illinois

Circle 489 on Page 19



Mfd. by
Braun Engineering Company,
Detroit, Mich.

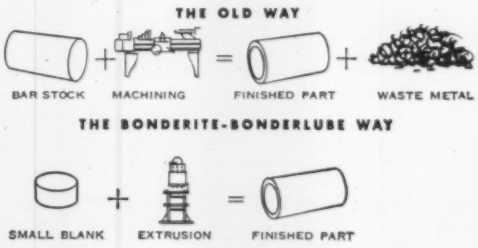
EXTRUDED...*and sold for less than the raw stock used to cost!*

Cold extrusion of steel means big reductions in material, machinery, and time. Frequently, as in the case of the automotive motor mount above, the part is made by cold extrusion for about the cost of the raw metal used in conventional methods.

More and more, manufacturers are turning to cold extrusion as a cost cutting, simplified method of making quality parts. Machining is cut to a bare minimum and scrap virtually disappears. "Impossible" jobs are being mass produced at high rates and a lot of the "impossibles" have become production runs only because of Bonderite and Bonderlube.

These two remarkable aids in cold extrusion make metal flow like magic. More severe deformations are possible. Tool and die life are multiplied. Rejected parts are few and far between. Production speeds are greatly increased. Smooth finishes are easily achieved and maintained.

The Parker cold forming staff can give you expert help in the technique of cold extrusion.



Since 1914—leader in the field

PARKER RUST PROOF COMPANY
2193 E. MILWAUKEE, DETROIT 11, MICHIGAN

BONDERITE	BONDERITE and BONDERLUBE	PARCO COMPOUND	PARCO LUBRITE	TROPICAL
corrosion resistant paint base	aids in cold forming of metals	rust resistant	wear resistant for friction surfaces	heavy duty maintenance paints since 1883

**Bonderite, Bonderlube, Parco, Parco Lubrite—Reg. U.S. Pat. Off.*

Circle 490 on Page 19

Circle 491 on Page 19→

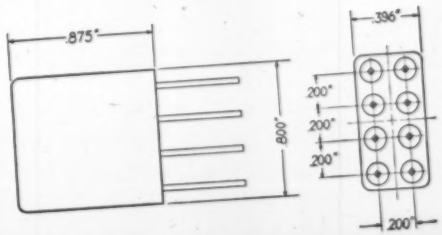
These could be the
MOST IMPORTANT RELAY "SPECS"
you ever read!

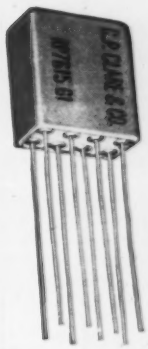
• Here is a relay admirably geared to the needs of today's advanced circuit designers. Hermetically sealed—no bigger than a postage stamp —stalwart to withstand extremes of temperature, heavy shock and severe vibration—yet fast and more than moderately sensitive.

CLARE *Type F* RELAY

SPECIFICATIONS

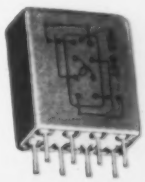
Ambient Temperature	—65° C to +125° C.
Shock	50 Gs for 11 milliseconds.
Vibration	5-75 cps at maximum excursion of ¼-inch, 75-2000 cps at 20 Gs acceleration.
Dielectric Strength	Sea level—1000 volts rms between terminals and frame, and between adjacent circuits; 750 volts rms between contacts of a set. At 80,000 ft., 350 volts rms.
Insulation Resistance	1000 megohms minimum at 125° C.
Coils	Coils up to 10,000 ohms available for a wide range of voltages or currents.
Nominal Operating Power	250 milliwatts.
Pickup Time	3.5 milliseconds nominal.
Dropout Time	1.5 milliseconds nominal.
Contact Arrangement	2 pdt (2 form C).
Contact Rating	3 amps resistive at 28 volts d-c or 115 volts a-c; also for low-level applications.
Contact Resistance	0.050 ohm maximum.
Contact Life	500,000 operations minimum at 2 amps; 100,000 operations minimum at 3 amps.
Enclosure	Hermetically sealed, filled with dry nitrogen at 1 atmosphere pressure.
Mounting	All popular mounting arrangements available.
Terminals	Printed circuit; solder; plug-in (matching socket available). Variations of printed-circuit terminal length on 1/10-inch grid spacing available.
Weight	17 grams.
Military Specifications	MIL-R-25018; MIL-R-5757C, except as to contact overload.





Designers of printed circuit layouts will note terminal arrangement is nicely suited to 1/10 inch grid spacing.

Contacts, rated at 3 amperes, are proven also for low-energy level circuit applications.



All popular mounting arrangements are available.

For complete information send for Bulletin 124. Address: C. P. Clare & Co., 3101 Pratt Blvd., Chicago 45, Illinois. In Canada: C. P. Clare Canada Ltd., 2700 Jane Street, Toronto 15. Cable Address: Clarelay

CLARE RELAYS

FIRST in the industrial field

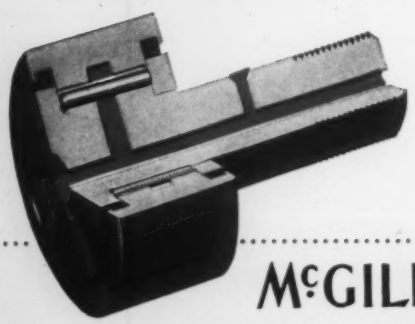
only McGILL® sealed *CAMROL*® cam followers give you . . .

effective sealing

prelubrication

high radial and shock capacity

in a full range of sizes



Effective sealing of the CAMROL cam follower against moisture, dirt, chips, etc. guarantees longer service life . . . reduces maintenance. This sealed construction retains lubricant and eliminates need for frequent relubrication, so often undesirable in cam action, guide support and track roller applications.

Special seals are built in at stud and flange ends. A black oxide finish on all exposed surfaces offers outside corrosion resistance. The channeled reservoir above the rollers in the outer raceway bore helps store reserve lubricant, sufficient in most cases for lifetime service. Relubrication is possible through convenient oil holes. The new SCF sealed CAMROL cam followers interchange with proven standard CAMROL cam followers. Standard stock with roll diameters up to 4″ are available for both stud and shaft mounting.

For maximum bearing life where contamination is a problem, specify sealed CAMROL cam followers. Ask your McGill representative or our engineering department for recommendations.

Write for Catalog No. 52-A

McGILL®

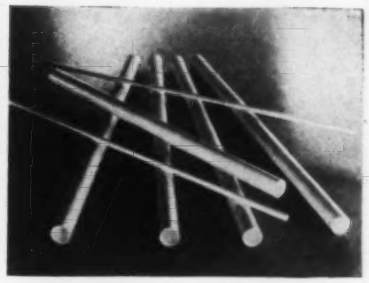
MULTIROL® GUIDEROL® CAMROL®
Precision Needle Bearings

McGILL MANUFACTURING COMPANY, INC., 200 N. LAFAYETTE ST., VALPARAISO, INDIANA

(Advertisement)

THIS IS GLASS

a bulletin of practical new ideas *from Corning*



News! PYROCERAM brand Tubing and Rod now available.

We flatter ourselves into thinking that a great many of you are familiar with PYROCERAM Crystalline Materials.

For the sake of review, however, this brief summary: PYROCERAM is the brand name given by Corning to a new group of ceramic crystalline materials made from glass. What with *nucleating* agents and some classified heat processing we end up with a material *unlike* anything you've ever seen. A number of variations, each exhibiting different *combinations* of properties, have been evolved.

On an overall basis, PYROCERAM Materials can be made lighter than aluminum; harder than carbon steel; stronger than tempered glass; immune to the corrosive action of most chemicals; unbothered by heat that warps steel and melts copper; possessed of electrical properties equal to the better ceramics.

And now you can get one variant in the form of PYROCERAM Tubing and Rod. Designated Code 9608, it is a *gastight* white *opaque* material. It has the thermal shock resistance that you'd normally get *only* from fused silica. On the Vickers Diamond Pyramid test it rates 550.

You can use this PYROCERAM Tubing at an operating temperature of 1000°C., *unloaded*—up to 500°C., loaded. (The latter figure is based on preliminary runs with indications that it's *too low*.)

Long-term chemical durability data will be available soon. But we can tell you that linear coefficient of thermal expansion is 9-15 (factor 10^{-7}) between 25° and 300°C. Specific gravity at room temperature is 2.50.

The enthusiasm shown by you when PYROCERAM Materials were first introduced suggests that these *new* forms should prove practical in varied product and process applications. Might just be that the idea you've been noodling around can now become a *reality*.

Inquiries aimed at our Technical Products Division will bring you all the very latest data on PYROCERAM Tubing and Rod.

And for your files, there's Progress Report No. 2. Check the coupon for your copy.

LATE FLASH!

Just announced—PYROCERAM brand Cement. This is a thermal-setting solder glass originally developed for sealing the closure panel on color TV tubes.

But, it turns out to be an unusually versatile material. You can use it for sealing glass-to-glass, metal-to-metal, ceramic-to-ceramic—and *any* combination thereof.

The cement is fired at temperatures of 400-450°C.—*and the cemented parts can then be used at these temperatures!* It's suited for materials having expansions falling between 90-110 x 10^{-7} cm/cm °C.

The people who know most about this say this *devitrified* glass makes for real fine joining—especially for applications that have proved difficult in the past.

You can get more information by again referring to the coupon.

Get 'em while they're hot

This is MEALPACK, a device for keeping train travelers, among others, happy.

It was developed by MEALPACK of Evanston, Illinois, and now is used by railroads, hospitals and other institutions. Purpose? Elimination of the *costly* and *cumbersome* arrangements needed for preparing hot food while trains are *en route* or food to be distributed throughout a big building.

The approach is simple: Prepare meals in central kitchen; place in PYREX brand dish, insert dish in insulated MEALPACK container. At mealtime waiter serves hot food in the original PYREX dish. No fuss, no muss.

Backing up a bit, a PYREX glass dish was the logical choice, first, because dishes are *heat-charged* to a skin temperature of 250° F. to act as a heat-battery for each meal.

Then, *piping* hot food is placed in the dishes by workers wearing gloves. But even with all this heat there's *no* worry about a PYREX brand glass—it won't crack, craze, or change shape.

Also the glass won't alter the taste since it *neither* adds to nor takes from what you put in it.

And these glass dishes *look* like fine crystal. Yet you'll *never* have trouble with cleaning since there are no rough spots to hold food. Hot water, cleaning agents, rough handling—nothing bothers these PYREX dishes.

Clincher: When you draw on Corning's glass know-how and production facilities you can get *quantity* delivery on the items you need, *when* you need them, and at a *price* that makes the whole project worthwhile.

A goodly portion of our daily work is devoted to providing glass *components* (in almost endless variety) to people like you.

For a good picture of this operation send for: IZ-1, "Designing with Glass for Industrial, Commercial and Consumer Applications"; B-84, "Manufacture and Design of Commercial Glassware."

You might also find "This Is Glass" of value. It's a 64-page word-and-picture summary of glass as a basic material of design and construction. FREE.

Corning means research in Glass

CORNING GLASS WORKS, 52-4 Crystal Street, Corning, New York

Please send me the following material: ☐ Progress Report No. 2; ☐ IZ-1, "Designing with Glass for Industrial, Commercial and Consumer Applications"; ☐ B-84, "Manufacture and Design of Commercial Glassware"; ☐ "This Is Glass"; ☐ PYROCERAM brand Cements.

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Company .....

Street .....

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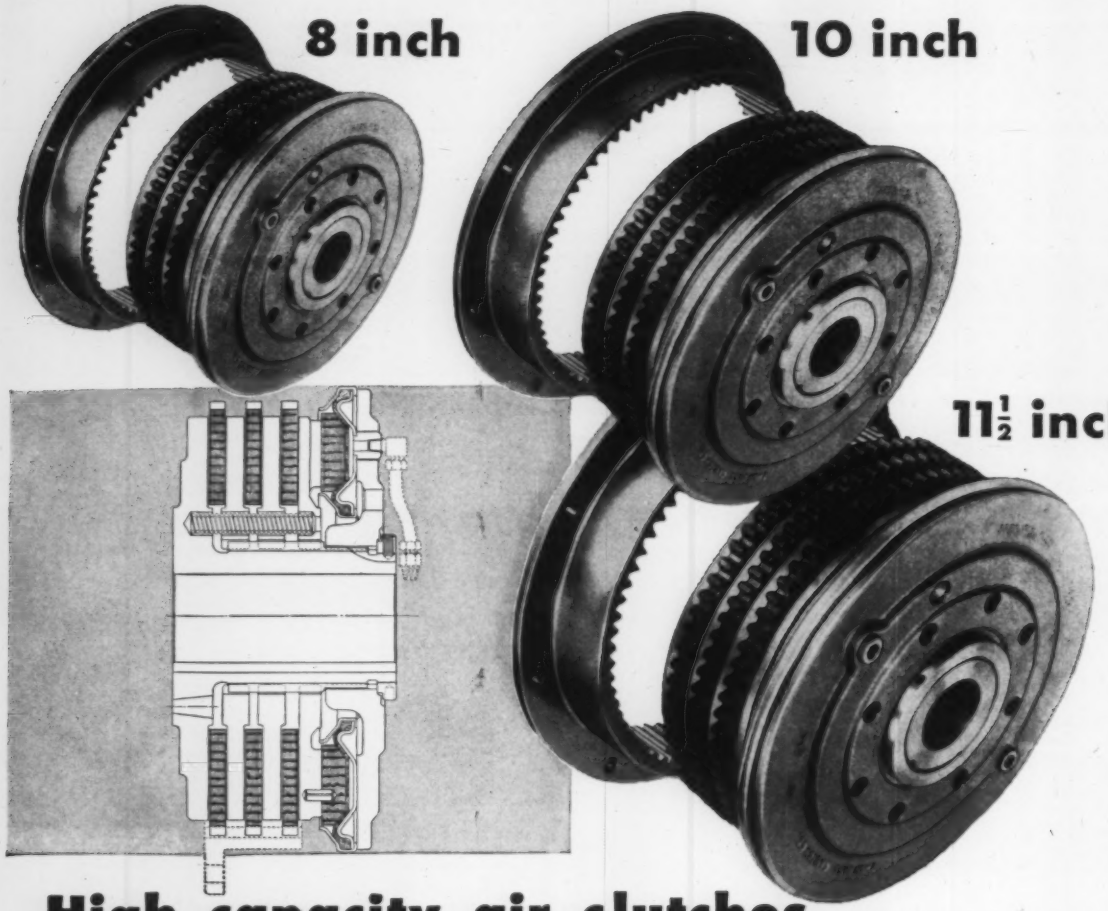
Circle 493 on Page 19



High capacity air clutches . . . up to 40% less in cost

Having clutch problems? . . . Then try the new low-cost Twin Disc 8, 10 and 11½-inch PO Air Clutches. You'll find in these new clutches all the quality and dependability associated with the entire PO Air Clutch line—*plus these important benefits:*

- **New design permits highest capacity at up to 40% less cost than comparable remote-controlled units.**
- **Torque capacities to 3480 lb.-ft.**
- **Available in triple-plate, double-plate and single-plate construction.**
- **Exclusive cartridge-type reinforced neoprene diaphragm eliminates leakage . . . provides longest life.**
- **Constant torque capacity without adjustment . . . self-compensating for wear.**
- **Narrow width permits replacement of old-style drum or band clutches . . . without extensive modification or redesigning.**
- **Suitable for air systems up to 130 pounds per square inch.**

These new PO Air Clutches are adaptable wherever the convenience of remote air control is desired. They already have proved themselves in such heavy-duty applications as rock crushers, tractor winches, pipe-extruding machines, drilling rigs, machine tools, pug mills and other industrial equipment.

Addition of the new clutches extends the Twin Disc PO Air Clutch line from 8 to 36 inches in diameter . . . to 127,100 lb.-ft. in torque capacity. There's a PO Clutch for virtually every application requiring convenient remote control for connecting and disconnecting power. Write Twin Disc Clutch Company, Racine, Wis., for complete details.

TWIN DISC

TWIN DISC

Friction Clutches and Fluid Drives

TWIN DISC CLUTCH COMPANY, Racine, Wisconsin • HYDRAULIC DIVISION, Rockford, Illinois

BRANCHES OR SALES ENGINEERING OFFICES: CLEVELAND • DALLAS • DETROIT • LOS ANGELES • NEWARK • NEW ORLEANS • TULSA

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MACHINE DESIGN
April 3, 1958

Consultant or Hired Hand?

TODAY'S employed engineer has reason to be confused. More often than not he's hired (and fired) just like any other worker; yet he's expected to regard himself as part of management.

Now comes evidence that management feels a need for more supervisors who can "push" engineers, as reported in the current installment of "Organizing for Productivity," Page 28 of this issue. Yet a true professional does not have to be pushed. Confronted with a problem and all the conditions surrounding it, he can be depended upon to bring to bear the necessary resources for its solution, on time.

That engineers, apparently, do have to be pushed perhaps indicates that too few have arrived at a full understanding of professional responsibility. On the other hand, if they are treated as employees under close supervision, how can they be expected to develop the dependable, consultant-type attitude that is typical of professional relationships?

Engineers themselves hold the key. Each engineer could do his job so reliably and professionally that his supervision would involve merely the transmittal of information and the co-ordination of activities. Then, perhaps, management would have reason to regard engineers more as consultants to whom problems are entrusted than as employees who have to be pushed into working at them.

Engineers who have not reached that happy state might well take a long, hard look at what it takes to earn such recognition. It's the attitude of the professional consultant versus that of the hired hand.

Management, in turn, might meet engineers half way and actively encourage development of such an attitude. The effect on engineering productivity could be highly rewarding.

Colin Carmichael

EDITOR

How to Measure Progress in

NEW-PRODUCT PIONEERING

by asking the right questions at the right times

By PHILIP R. MARVIN
Manager
Research and Development Div.
American Management Association
New York, N. Y.

DRAMATIC successes await companies that have have built carefully planned, active programs for new-product pioneering. The Schick electric shaver, Hamilton's electric wrist watch, and the Hammond electric organ are representative pioneer products familiar to almost everyone. Although all these are electrical-mechanical devices, an analysis of nearly any product group will reveal the pioneer product—the innovation—and the copies subsequently produced by others.

Today, pioneering products represents an area of management endeavor in which horizons are unlimited. In spite of this, many companies have not been successful with new-product programs. Lack of aggressive programs can usually be traced to a feeling by executives that they do not have enough appreciation of the problems involved to effectively administer new programs. This feeling is intensified in many companies by a lack of mutual understanding between top management and the technical people responsible for these programs.

Planning a program and getting it started are only half the job. Maintaining a running check throughout the development phases and steering the program to a successful conclusion are even more important. When a program flounders, those concerned—management, engineers, scientists, sales people—must know what remedial steps to take.

Managements with experience from successful new-product programs have learned to delineate the various steps in product development and have devised checks at each point to measure progress. The questions asked at these steps can provide other firms with insight into problem areas which often prove to be stumbling blocks. If these same questions are asked during steps in any new-product development, most disasters will be circumvented. This article shows how a typical program is broken down into steps, how the checkpoints are set up, and what management needs to know at each one.

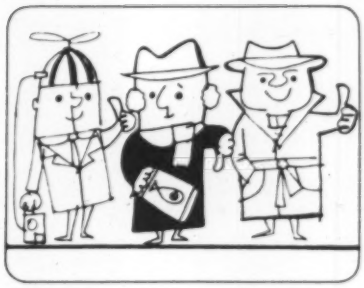
Development Phases: A new product, or the redesign of a going product, passes through five phases before it reaches the ultimate customer: 1. Evaluation. 2. Application. 3. Commercialization. 4. Production. 5. Distribution. While these phases are easily identified, boundaries between phases are difficult to distinguish. An overlap between activities and a continuous feedback of information are characteristic.

Control points are established to measure the evolution of a concept into the hardware of a commercial product. At each of these control points management should measure progress by asking the right questions. Those responsible for the program should know what questions to expect and should be prepared to supply authoritative answers. When engineers and others working on a project can give accurate answers, management will be better equipped to plan for stability and growth.

PHASE 1—EVALUATION

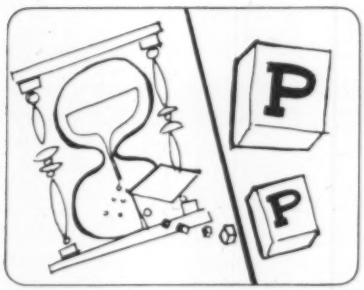
1 What do we know about it?

Answers to this question form the groundwork for all further investigation. Among the data that must be gathered and evaluated are prior history, market estimates, technical feasibility, and other pertinent information that form a background for the idea as it stands. All accumulated knowledge should be reviewed and brought up to date in the light of current technical, economic, and competitive developments. The latest information on patent situations and a current-literature survey should be included. The importance of this step cannot be overstressed.



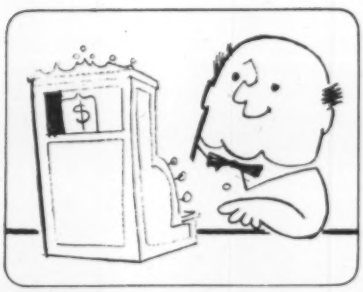
2 Shall we try?

All the thinking that has developed must be applied to answer this question. At the outset it is relatively easy to maintain an analytical attitude. This becomes much more difficult as time goes on. Interesting facets develop that attract personal interests and opinions and destroy impartial viewpoints. The information gathered to support this decision must be completely unbiased, open to question, and remain so. The individuals involved must be prepared to support their decisions in discussions that may become both partial and quite heated.



3 How long will it take?

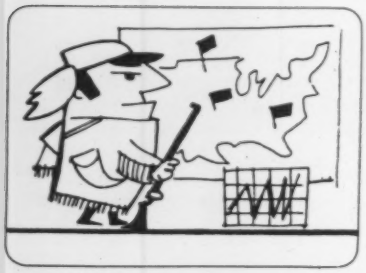
Ideas develop into products through use of available money, manpower, and machines. Since few companies have any of these in surplus, schedules must be established to determine the time-cost relationship. While a short development time may run up costs due to inefficiencies, longer development periods may sacrifice marketing opportunities. Reasonable estimates of development time require schedules that balance timing with associated costs of resources necessary to implement the program. Accurate time estimates are essential and should be followed closely.



4 Will it pay to do it?

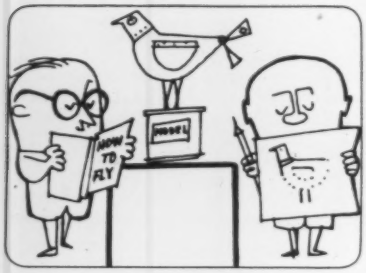
This question must be answered by an educated guess based upon investigations of practicability of the product, nature and size of market, sales methods, manufacturing requirements, management and organizational requirements, and the profit potential. It is far less expensive in the long run to spend time and money to fully define every aspect of the situation than to uncover facts later that require backtracting. Because of the many intangibles involved, all possible facts must be marshalled for use. Decisions based upon guesses can be costly.

PHASE 2—APPLICATION



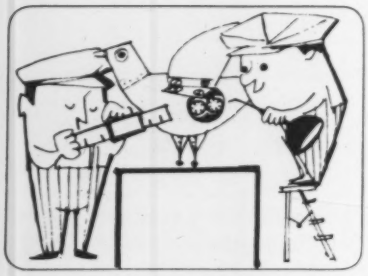
5 What can we discover?

As a final review before prototype construction, the mechanical aspects of the new product should be rechecked. The product is then completely engineered with the expectation that it will become a production item. The latest developments in technology should be studied and included where possible to offset the possibility of rapid obsolescence. All practical ideas and suggestions should be gathered, studied, evaluated, and used when possible. Except for debugging and modification, this is the climax of the engineering-development process.



6 Will it work?

Without an operating model, there is very little of the new product that is tangible. At the earliest time consistent with research and engineering programs, an operating breadboard model should be constructed to prove out any innovations or departures from previous practice. The general objective is to prove the practicability of the product. Tests should be designed that check out the intended functions of the product. How satisfactorily these functions are performed should also be measured. If the results are unsatisfactory, additional work is needed.



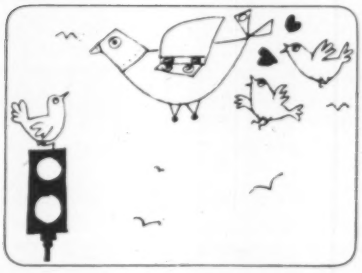
7 How shall we build it?

When the functional requirements of the model have been decided upon, the actual engineering and construction can begin. The model should reflect a realistic relationship between available materials, operating principles, and established requirements. In reducing the idea to practice, the scientists and engineers are working together to give the ideas physical form and being. A very strong effort should be made to include as many of the final desirable features as possible, such as ease of maintenance and operation. The next phase is commercial evaluation.

This article is the last in a series that present all aspects of new-product development. The seven preceding articles have told of the importance of proper product strategy, how to develop, screen, and appraise new-product ideas, ways to organize research and engineering for such programs, and how these departments operate with market research and the rest of the organization in assuring success of the project. These articles have appeared in the following issues of MACHINE DESIGN:

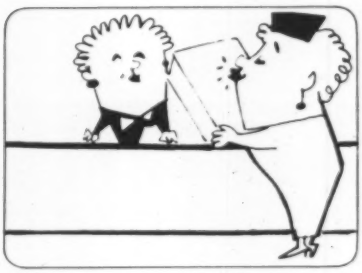
"Planning Product Strategy" ..... June 13, 1957
"Developing Ideas for New-Product Programs" ..... July 11, 1957
"Profitable Fields for New-Product Development" ..... August 8, 1957
"Screening and Appraising New-Product Ideas" ..... September 5, 1957
"Research for Results" ..... October 17, 1957
"How to Organize Engineering for Product Development" ..... December 26, 1957
"How to Combine Research + Engineering + Markets" ..... February 20, 1958

PHASE 3—COMMERCIALIZATION



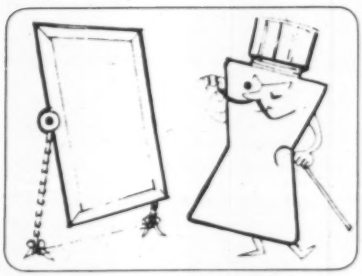
8 Shall we go ahead?

Once ideas approach the pilot stage, management takes a greater interest. Questions become more pointed and answers are expected to be more specific. Management recognizes that it must decide about pilot runs to gather additional manufacturing and marketing data. This, in turn, will again increase the investment. Seeing the model in physical form will stimulate exploration of its potential. While management is thinking out loud, much can be learned from their reactions that will be of value in planning and in preparing for subsequent developments.



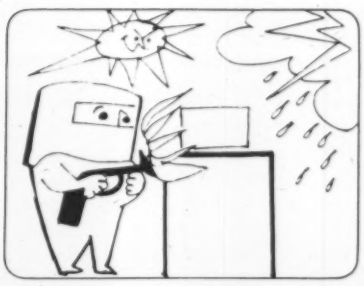
9 Does it have everything?

The model built earlier was for providing functional performance. In this phase, a final prototype is built. It must perform for the customer under actual operating conditions and duplicate the product to be offered for sale in every way except method of manufacture. Naturally, first consideration must be given to performance, since the product must do the job for which it is intended. The customer must be pleased. After-purchase servicing must be taken into consideration. Costs must be kept in line since the selling price will influence both sales volume and profits.



10 How does it look?

Development of the prototype should be undertaken with a this-is-it attitude. All available data relating to problems that may be encountered in production, distribution, performance, and servicing should be digested and the final solutions incorporated in the prototype. Once it has been completed, management, production people, sales personnel, distributors, dealers, buyers, and others will review it and comment upon it. Although unanimous approval is rarely encountered, top-management decisions must be made and final approval must be secured.



11 Does it work?

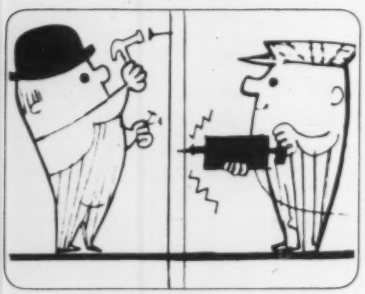
Criteria for sound performance are based upon knowledge of how the customer will use the device. First-hand knowledge is required — not theory. Unless customer service requirements are kept in mind, tests will be too severe in some cases and inadequate in others. The former results in over designing, the latter in performance failure. Either extreme will prove costly and may kill the profit potential predicted for the product. The performance tests to which the product is subjected must be thorough and duplicate actual customer operating conditions.

12 Can the customer make it work?

Prototypes should be tested by putting them in the hands of customers for actual use. The results of field tests are varied, interesting, instructive, but above all, proof of the adequacy—or inadequacy — of a new design. The engineers who have lived with a project and are familiar with it are frequently completely unable to imagine the approach that the customer may have to its use. Only field tests can establish the real performance limits of the product and the adequacy of the design. The results of these tests are then gathered and analyzed for use.

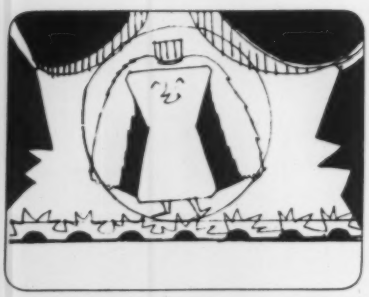
13 How can it be improved?

Since prototypes rarely pass all performance tests, the test results must be evaluated to determine new design requirements. Successful products are generally evolutionary; thoroughness, persistence, and patience during the development phase are keys to a soundly designed, competitive product. Time and money spent in perfecting designs reap tremendous savings in delays and charges for in-production changes later. Eagerness to get the product on the market must not be permitted to overrule development of sound designs or incorporation of improvements.



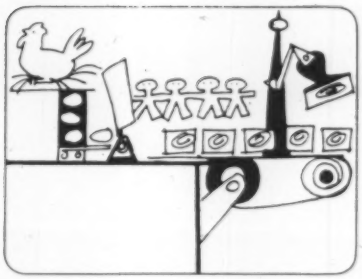
14 Will manufacturing modify it?

When a satisfactory prototype has evolved, it must be turned over to production people, even if it is not easy to break away from engineers who can see more work to be done. Review and modification for low-cost production include both changes suggested by available production equipment and knowhow and by consideration of purchased parts, subassemblies, and materials. If these proposed changes leave prior performance - test results open to question, the tests must be repeated. Experience gained before should simplify and speed up the new tests.



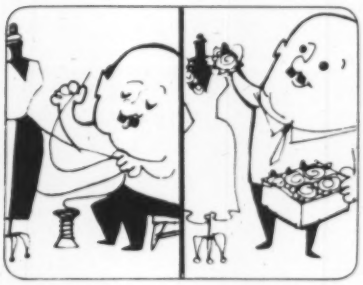
15 How does it look now?

Final models represent thoroughly worked-over designs ready for approval by all concerned. Comments must be expected, like: Sales manager, "Price too high, insufficient styling." Production manager, "Hard to build." Engineers, "Not ready yet—rushed too much." Accountant, "Costs too high." Puchasing, "Can buy complete for less money." Watchmen, "That thing still here?" These comments must be taken philosophically. Since good men can and want to do better, this is a healthy condition. At about this point, the model is finished and production planning begins.



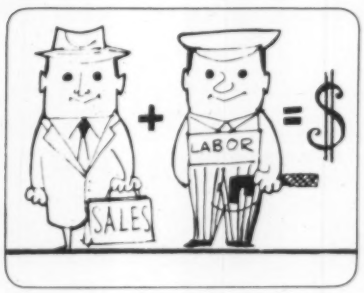
16 How do we make it?

Manufacturing personnel keep costs of both time and money foremost in mind when processing a new design. The lowest per-piece cost may require entirely new production facilities with single-purpose machinery and tooling. Getting the product on the market in the shortest possible time may suggest simple tooling and use of existing facilities only. The optimum (never perfect) solution is usually someplace between these two extremes and requires the best in planning and projecting of eventualities. Plans must be left flexible to meet future requirements.



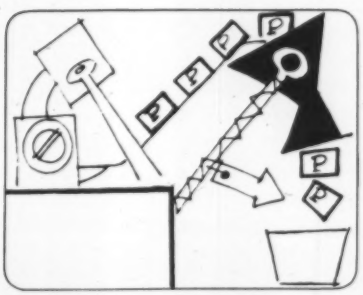
17 Do we make or buy?

Products can be manufactured or purchased, in whole or in part, and both methods are usually used. Determination of the proper course requires a careful study of each individual part of the product. If the product was designed for the firm's own facilities, alternate designs of some parts may be considered for cost purposes. Purchasing as an alternate to manufacturing frequently raises concern over utilization of fixed investment. However, net cost per piece should be the actual determining factor between make or buy. Buying may require minor design revisions.



18 What are total costs?

Final cost of a new product is the sum of manufacturing costs and cost of purchased components. This figure is used in developing the optimum selling price for the product and must be based upon sound costing practices. If the costs are in line with the proposed sales price, all well and good. If not, stop here. Everything before is part of the process of developing a salable product. If the costs are not right, sales volume will be adversely affected and this, in turn, will raise the costs and squeeze profit margins. Too-high costs may kill the project.



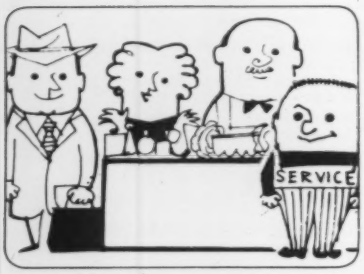
19 How many for a trial run?

Pilot production provides limited quantities of a new product for market development without incurring full investment of production tooling. Thus products can be proved out under actual sales and operating conditions at minimum cost. Sales experience must be gained to evaluate customer acceptance. If the response to the product is favorable, demand may develop with unexpected rapidity. Pilot runs permit maintaining small stocks until full production can get started. While plans and programs are being turned into facilities, the product passes into the distribution phase.

PHASE 5—DISTRIBUTION

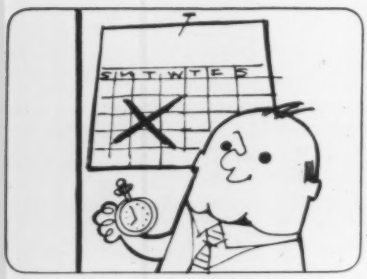
20 Do sales justify production?

The sales program for pilot-run products should be constructed in the same manner used for full-scale selling, and potential buyers should be unaware of the experimental nature of the program. This approach provides effective data for evaluation of sales and marketing approaches. Because final production release calls for a major investment and changes are costly and difficult, the pilot run and initial market test must provide all data necessary for evaluating the soundness of the new-product program and to establish production levels if the green light is given.



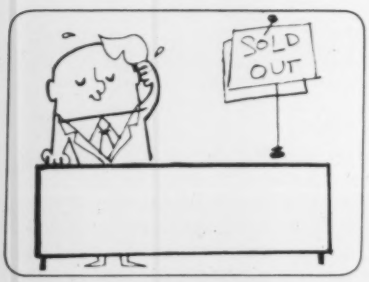
21 How good is our sales and service?

Fundamental consideration in setting up distribution channels is to achieve the most profitable way of making the product available in the quantities needed when and where the buyer is ready to purchase. The selling group must be ready to take over and sell the product as it rolls off the assembly line. Timing of sales and advertising is important to assure availability of merchandise as demand is created. Provision for servicing the product must be set up before it is offered for sale on a wide-scale basis. Rapid, efficient service is needed for the customers.



22 When do we start?

In one sense, manufacture commences with a turning of the wheels, but in an equally real sense the process commenced much earlier. Success of the "wheel-turning" phase is so dependent upon preceding steps that it is of minor significance in itself. The unfolding of programs planned in the previous stages of new-product development reveals the time at which effective and economical production can commence. However, if earlier steps were slighted, costs will be incurred that may ruin eventual profitability and require abandoning the product.

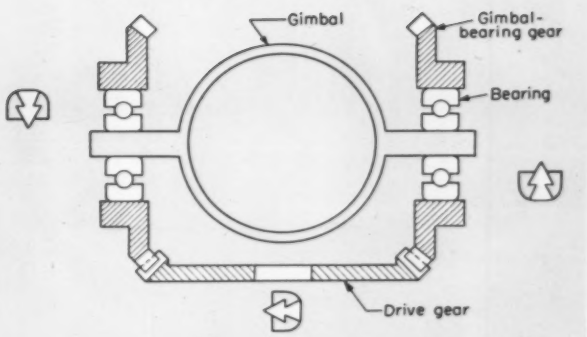


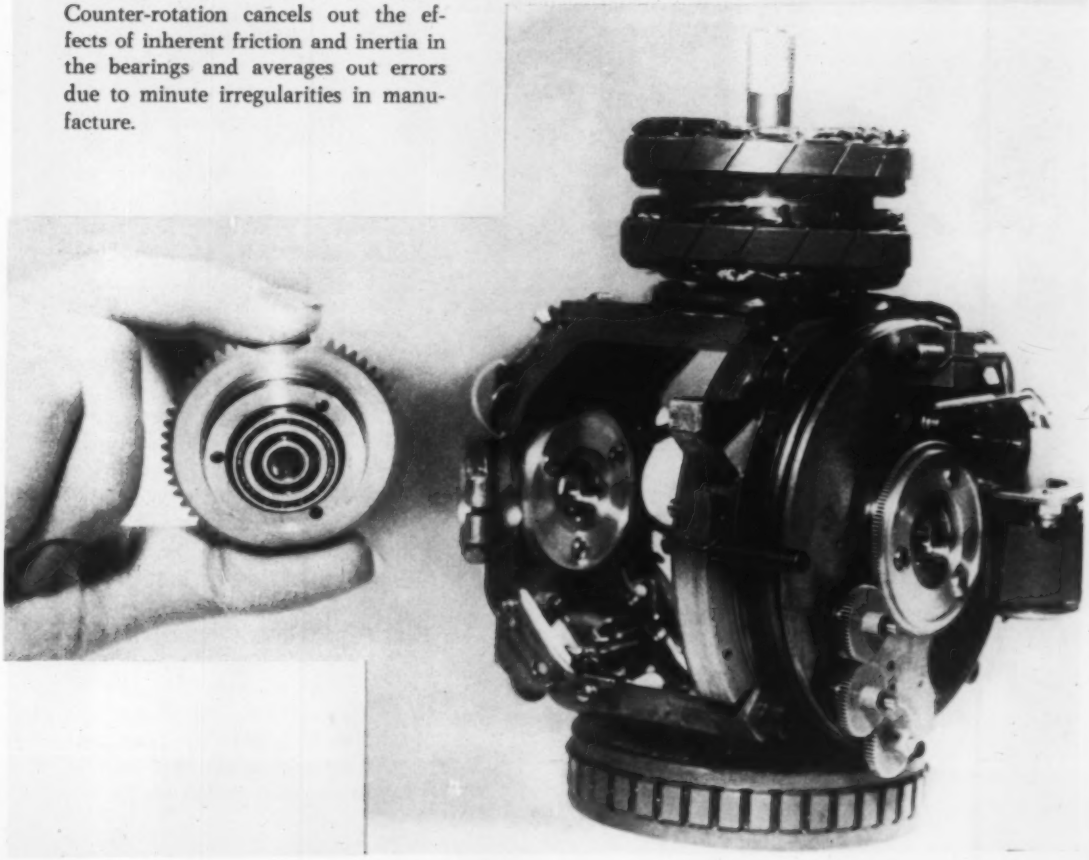
23 How is it doing?

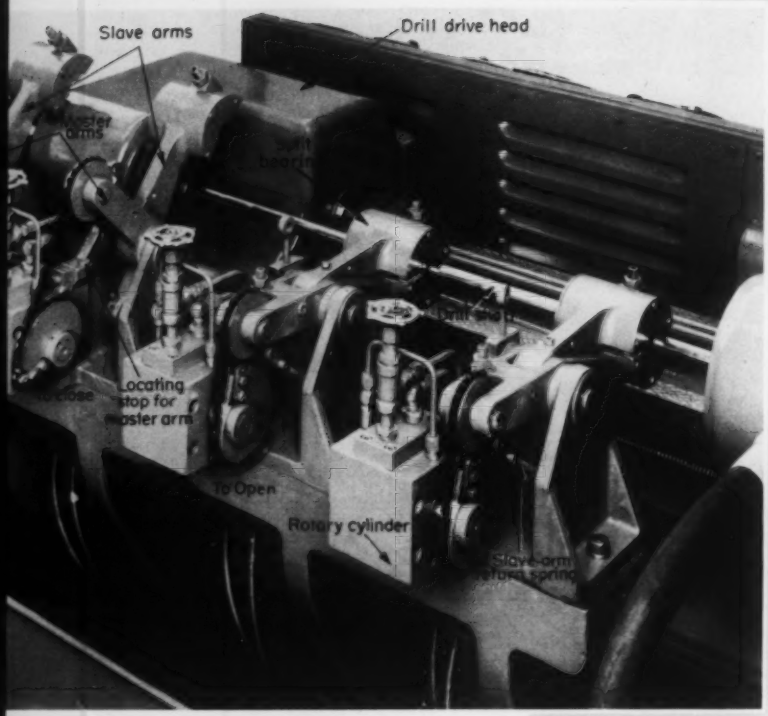
Problems encountered after new products are released for production and sale can seldom be solved by treating them as isolated cases. Somewhere, somehow, an essential step has been overlooked or poorly executed. The steps in the entire program may have to be retraced and all subsequent work reprogrammed. Every possible effort should be made to quickly solve problems as they arise and to locate their origin in the planning phases. Careful reanalysis may head off subsequent difficulties, costly delays, and lost sales. Sound development programs bring success.

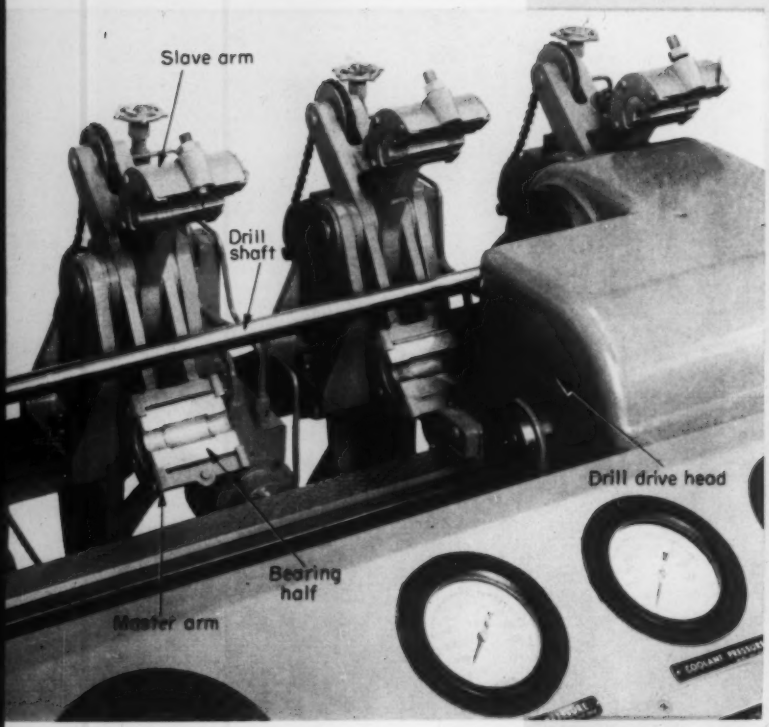
scanning the field for *ideas*

Counter-rotating ball bearings in a precision suspension system for instrument gimbals cancel out effects of errors due to friction and production irregularities. The design was developed by Sperry Gyroscope Co. for application to gimbal-suspension bearings in precision gyro systems. The ends of the gimbal member are supported by ball bearings, the outer races of which are rotated in opposite directions by an external drive source. Counter-rotation cancels out the effects of inherent friction and inertia in the bearings and averages out errors due to minute irregularities in manufacture.







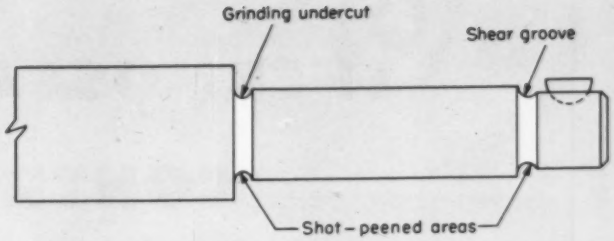


Scissor-bearing design offers an effective solution to precision support of long rotating shaft members where freedom for linear movement of power source is required. The scissor design consists of two arms, a master and slave, mounted on a common shaft. Each arm carries one-half of a split bearing. Both arms are operated by a rotary hydraulic cylinder which transmits motion to the arms by means of a half-heart cam and a chain.

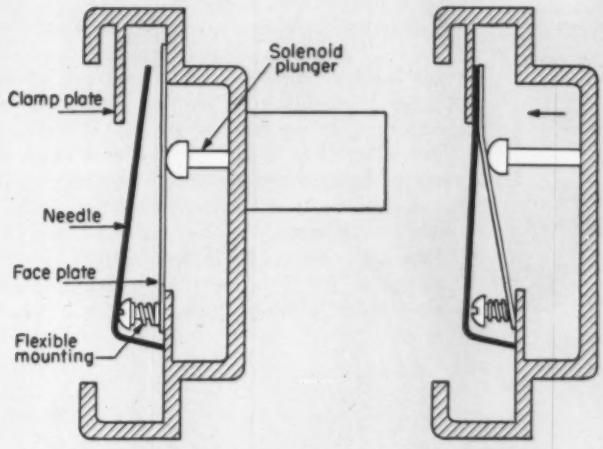
The chain passes over a pulley on the master arm and is anchored to the end of the slave arm. The arms are normally held in the open position, away from the shaft, by two springs of unequal strengths; the stronger spring is on the slave arm. Starting from the open position, the arms are closed by actuation of the hydraulic rotary cylinder. As the cam rotates, the chain pulls the master arm into the support position where the end of the arm contacts a fixed stop. The stop accurately locates the angular position of the master arm and its half bearing for precise alignment with the shaft. Since the cam is still rotating, the chain then closes the slave arm, which carries the other bearing half, to complete the bearing surface.

The device was developed for the LeBlond Carlstedt rapid borer to provide precise location and support for the drill, yet permit the drill drive head to pass by. As the drill feeds into the work, the drive head advances past the location of the drill-support bearings, tripping the hydraulic cylinder to open each one as it approaches. As the cam rotates to release the arms, the slave arm opens first due to its stronger tension spring.

Fatigue protection for reduced cross-sectional areas in shafting is provided by shot-peening the undercut surface. In the technique developed by Metal Improvement Inc., shot peening is used to provide surface compressive stresses that resist fatigue but do not alter the shear-strength values. Shear grooves on shafts are a typical application.

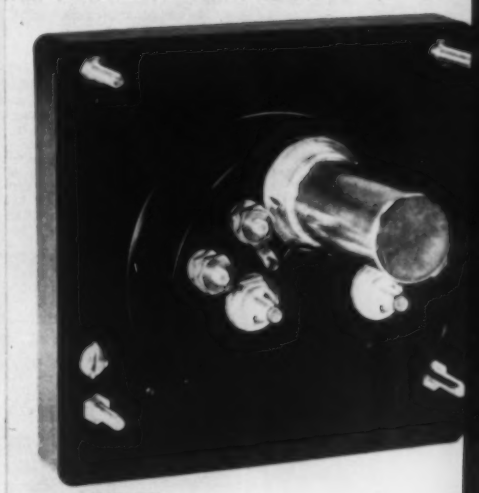


Built-in mechanical memory for indicating instrument is provided by a flexible dial-face mounting which permits the face and the indicating needle to be clamped together to preserve instantaneous readings. Developed by Assembly Products Inc., the design utilizes a solenoid whose plunger bears against the reverse side of the dial face. The solenoid is normally energized, holding its plunger away from the dial face and leaving the needle free to move for visual indication. To preserve a reading, the solenoid is de-energized and the plunger is driven against the dial face under spring pressure. The flexible mounting of the dial face permits it to deflect, clamping the needle against an overhanging plate.

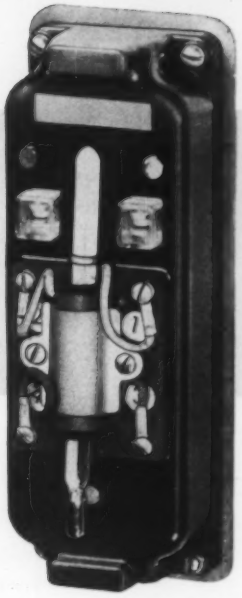


Needle Operating

Needle Locked



THERMOSTATIC CONTROLS



THE MOST generally accepted method for keeping electrical and electronic components at normal operating temperatures is to use heaters, blowers, or a combination of both. Obviously, the operation of such heating and cooling devices must be controlled. This can be easily accomplished automatically by means of a thermostat —a thermally operated switch.

Although the principal function of the thermostat is temperature control, there are other design applications in which these devices are used with considerable success. They may be applied as overheat detectors in aircraft engines or railroad train bearings, or as overheat protectors in electric motors, to name a few.

In general, themostats can be divided into two groups: 1. Those operated by the expansion and contraction of a metal. 2. Those operated by the expansion and contraction of a liquid. Although there are many types of thermostats within each group, this article will deal only with the three most widely-used types: 1. The bimetallic strip and disc. 2. The expanding shell. 3. The mercury type.

Table 1—Application Characteristics of Thermostats

Type	Favorable	Unfavorable
Bimetallic Strip	Small differential[1]. Adjustable temperature setting. Inexpensive.	Slow make and break[2].
Bimetallic Disc	Fast operation[3]. Large current capacity. Inexpensive.	Large differential. Fixed temperature setting.
Expanding Shell	Small differential. Adjustable temperature setting. Large current capacity. Temperature anticipation[4].	Large size. Slow make and break. Expensive.
Mercury	Small differential. Fixed operating temperature (set point)[5]. High shock resistance. Long useful life.	Small current capacity. Fixed temperature setting[6]. Expensive.

1. Difference between the opening and closing temperatures.
2. This may result in serious arcing and pitting of the contacts.
3. In the order of 0.00016 sec.
4. The ability to detect rapid temperature changes and as a result operate prior to reaching the temperature setting. This reduces temperature overshoot and undershoot.
5. Fixed set point means absence of tendency for temperature setting to shift.
6. Providing an electric heating coil around bulb furnishes means for varying temperature setting.

Bimetallic-Strip Thermostats

It is well-known that different metals have different coefficients of linear expansion. In the bimetallic-strip thermostat two strips of dissimilar metals are bonded together. When the temperature of this bonded pair—called "bimetal"—is changed, the unequal expansion of the two metals causes the strip to bend in the form of an arc. In the case of a bimetallic strip designed of Invar and brass elements, the extent of the strip's bending is a function of the thickness of the metals used, the difference in the linear coefficient of expansion of the two metals, and change in temperature of strip.

Obviously, the bending of a bimetal, resulting from a change in temperature, provides an excellent

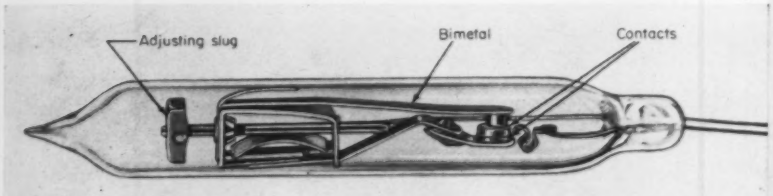


Fig. 1 — Glass-enclosed, sealed thermostat which is typical of those used for automatic control of electric circuits

Basic types • Theory of operation • Design considerations • Application data

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means of making and breaking electrical contacts. This, in essence, is the basic function of a thermostat—to open and close automatically an electrical circuit in which a heating, cooling, or other device is connected, Fig. 1.

One of the most common uses for this type of control is in the adjustable thermostat which automatically regulates the air temperature in homes. Another widespread application is in electric home appliances, such as the steam or dry pressing iron. This type of control, though usually without the temperature adjustment feature, is also frequently employed for maintaining constant temperature in quartz-crystal ovens, tuning-fork frequency standards, and similar equipment. In Table 1 are listed bimetallic strip characteristics.

▶ Bimetallic-Disc Thermostats

Like the bimetallic-strip thermostat, the snap-action disc control operates on the principle of unequal expansion of two dissimilar bonded metals. All similarity between the two types ends here, however.

The disc, punched out of bimetal sheet stock, is formed into a concave shape. It is this concavity which gives the disc its important characteristic of snap-action. When the temperature of the disc changes by a certain amount—the operating differential—expansion of the metal on one side becomes appreciably greater than that on the opposite side. Stress created by the unequal expansion overcomes the inherent inertia of the disc with a resultant inversion or "snap." As the temperature of the disc changes in the opposite direction, the process is reversed and the disc snaps back into its original shape. Both of these changes in shape are extremely rapid.

Switching action of such a control is provided by a pair of contacts, one of which is spring loaded, thus tending to keep the contacts closed, Fig. 2*a*. An increase in ambient temperature causes the bimetallic disc to invert, pushing upward on the ce-

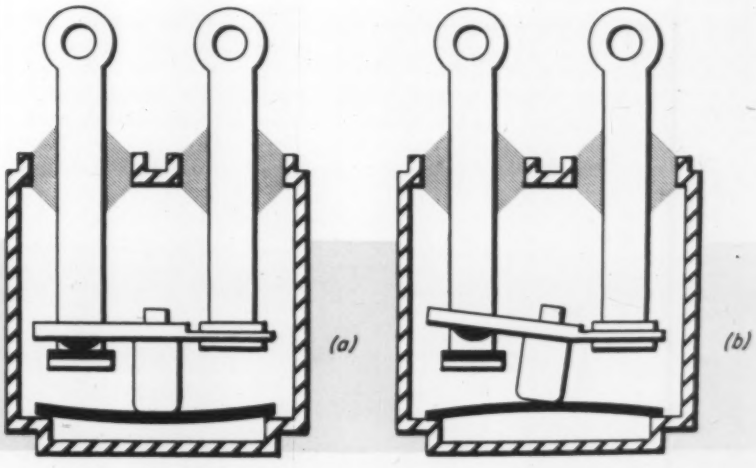


Fig. 2—Disc type control shown in closed position in *a* and open in *b*. Rise in temperature inverts disc, opening contact

ramic pin and causing the contacts to open, Fig. 2*b*. This type of thermostat may also be designed to close on temperature rise. In such a control, the bimetallic disc is reversed. The spring-loading feature makes the control insensitive to vibration, thus qualifying it for use in guided missiles, aircraft, and other such applications.

Although the disc thermostat is most frequently used as a temperature control, it is also employed as an overheat protector in electric motors. For such an application, the design of the thermostat is modified so that one or two pairs of contacts are an integral part of the bimetallic disc, Fig. 3. The motor protector is mounted in the field winding of the motor and connected in series with the latter. With the motor running, the field current passes through the bimetal. When the motor becomes overloaded or the rotor locks, the field-winding temperature rises rapidly. This increase in temperature is sensed immediately by the protector which operates, opening the motor circuit. Thus, damage to the motor is averted. The motors in many household refrigerators are protected in this manner. Characteristics of the bimetallic disc thermostatic control are also listed in Table 1.

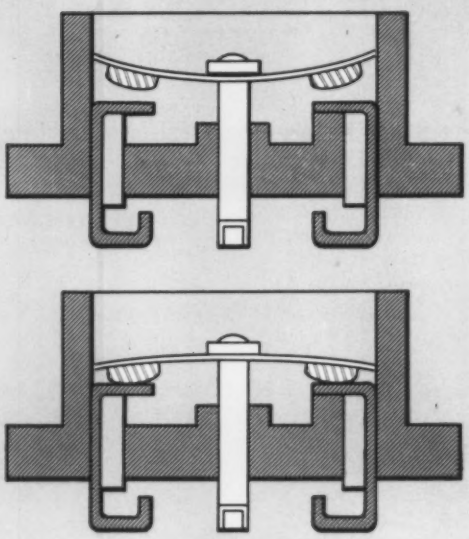


Fig. 3—Disc thermostat is useful as overheat protector when modified to make contacts part of bimetallic disc

Expanding-Shell Thermostats

Automatic switching action can also be obtained by harnessing the expansion of a homogeneous metal. In this case, a hollow tube made of brass, or other metal having a high coefficient of linear expansion, is the operating medium.

One such type of thermostat is shown in Fig. 4. The electrical contacts are mounted on, though insulated from, two curved metal struts which have a low coefficient of linear expansion. The struts are mounted between an anchor pin bonded to one end of the shell and an adjustable stud which passes through the adjusting sleeve fitted in the opposite end of the shell. This type of thermostat is adjusted for any temperature within its range by turning the adjusting sleeve; in one model, a full turn of the sleeve changes the setting 80 F. A locknut can be fitted on the sleeve to prevent change of setting through tampering or extreme vibration.

This type of expanding-shell thermostat is designed for either "tension" or "compression" operation. In the tension-operated device, temperature increase causes the shell to expand more rapidly than the struts, thus forcing the contacts to operate. Such a control is not damaged by temperatures considerably lower than the operating temperature, i.e., temperature undershoot.

Where temperatures will be reached which are well above the operating point of the thermostat—temperature overshoot, a compression-operated control is generally used. In this type, the structure is initially under compression; any increase in temperature relieves this compression, causing the contacts to operate. Obviously, any further increase in temperature merely allows this compression relief to continue with no resultant harm to the thermostat. However, this type of control will be damaged if subjected to extremely low temperatures, since such low temperatures cause excessive compressive force on the internal structure.

Another expanding-shell thermostat design, which is both hermetically sealed and adjustable is shown in Fig. 5. Here again, the shell which encloses the internal mechanism and provides the operating force is made of material having a large coefficient of linear expansion. The principal member, *A*, of the internal structure in Fig. 5 is made of Invar, which has a very small coefficient of linear expansion, and consists of two rigid sections with a common flex-

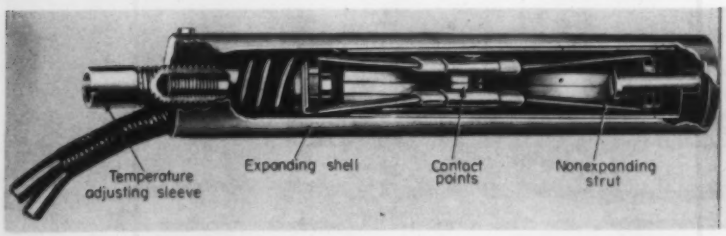


Fig. 4 — Expanding-shell thermostat. Unit shown operates on temperature rise. Struts are drawn straight by expanding shell to open contacts in thermostat

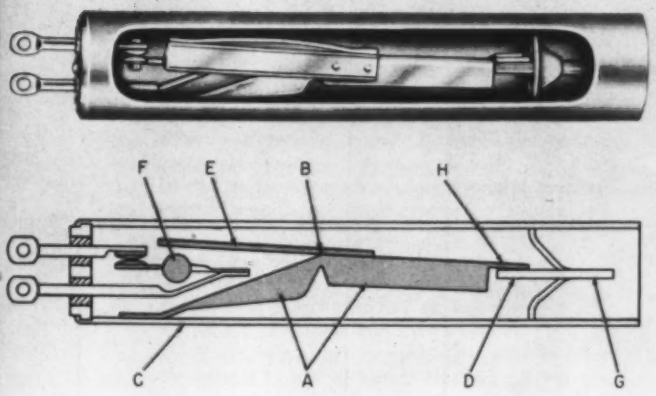


Fig. 5—Above—A hermetically sealed and adjustable expanding-shell thermostat design. Contacts open on temperature rise

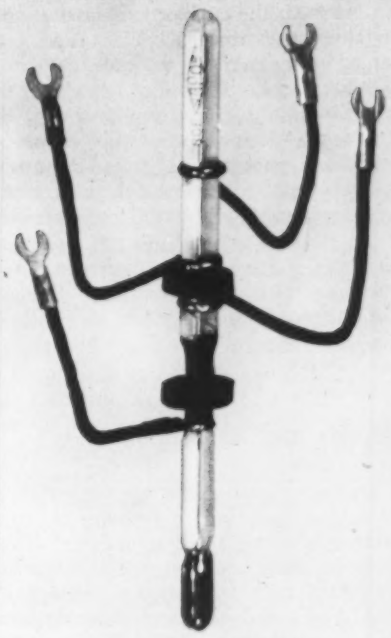


Fig. 6—Right—Mercury thermostat differs from a thermometer only in substitution of contact wires for the temperature scale

ing point at *B*. One end of this Invar member is welded to the shell at *C*, and the opposite end is fastened by the adjusting tongue *D* to the other end of the shell. With an increase in temperature, the shell expands, exerting tension on member *A*, causing point *B* to move downward. This motion is multiplied by the extension arm *E*, which bears against the glass insulating bead *F* and opens the contacts. In one model, the motion produced at the contacts is 15 times the longitudinal expansion of the shell.

The rigid terminals pass through a glass header which not only serves to insulate the electric current passing through the contacts, but also provides a hermetic seal. The opposite end of the shell is sealed off by the metal diaphragm through which the adjusting tongue *G* passes. The temperature setting is adjusted by deflecting the tongue with respect to the longitudinal axis of the shell. This moves point *H*, thus either raising or lowering the temperature at which the contacts open or close. Fig. 5 shows a thermostat whose contacts open on temperature rise. A similar control whose contacts close on temperature rise is also available.

Other types of expanding-shell controls are available, but these are basically similar to the two kinds shown in Fig. 4 and 5 and differ principally in that a switch—usually of the "sensitive" type—is substituted for the internal contact arrangement. This switch usually is mounted external to the tube and is actuated by a rod extending from the shell. Such a device can provide a more elaborate switching action than the customary single-pole, single-throw action of the basic expanding-shell thermostat.

The expanding-shell thermostat is widely used as an overheat detector in aircraft engines. When the engine temperature exceeds a certain predetermined value, the thermostat operates, closing an indicator light circuit and thus warning the pilot of the overheat condition. This greatly reduces the possibility of serious aircraft fires. Other uses are in the plastics and chemical industries, where the control may be inserted in dies or immersed in liquids and still retain a readily adjustable temperature setting. The characteristics of this type of control are listed in Table 1.

Mercury Thermostats

In some respects, the mercury thermostat is the simplest of all thermostatic controls. It operates on the same principle as the mercury thermometer. Since it is a control rather than an indicator, a means of opening and closing an electric circuit is substituted for the degree scale. This is accomplished by inserting two or more wires in the side of the tube and extending them into the bore for the mercury column.

Although the principle of operation of the mercury thermostat is quite simple, the techniques involved in its manufacture are complex, and require a high degree of skill and precision. The bore for the mercury column measures only 0.008 in., and must be held within very close limits to provide the desired control accuracy. When the bore has been completed, the tube is cut at those points where contact is to be made with the mercury column. Fine platinum wires are inserted so that they extend 0.002 in. into the bore. The number of contact wires depends upon the number of control opera-

tions desired; the minimum number is two for the simple "on-off" switching action. After the wires have been inserted, the cut portions of the tube are joined together and resealed. The tube bore is then charged with mercury under extermely high vacuum. Nitrogen at 125 psi is introduced above the mercury column and the tube is sealed, Fig. 6.

In many applications the glass tube is too fragile for use without a protective cover. Many metal housings are available, some of them serving also as a means for mounting and making electrical connections.

A typical use of the mercury thermostat is in the temperature control of airplane cabins. The characteristics of this type are also given in Table 1.

Selection and Application

Many engineers, either through oversight or in an effort to cut costs, fail to provide for necessary temperature control of their equipment. This can be a serious and costly mistake, and one that usually can be rectified only by a major redesign of the equipment or by a makeshift and inefficient arrangement of the temperature control devices.

When the need for temperature control is recognized early in the equipment design stage, there often is a tendency to "overprotect" the equipment. This occurs when a thermostat is chosen with the smallest available differential and is as closely coupled as possible with the heating or cooling device. Such extremely close control is sometimes necessary, as in temperature compensating of a quartz crystal. However, such close control entails frequent operation of the thermostat, which somewhat reduces useful life. Design characteristics of the four types discussed are given in Table 2.

General Rules: The choice of a thermostat is often a matter of compromise. The proper temperature control can be chosen only after all the factors involved have been considered and evaluated for their relative importance. The following design and application considerations may prove helpful in the design of equipment which requires temperature control.

1. Determine early in the equipment design stage if temperature control will be necessary. Unless environmental tests have established that all the electrical components, hydraulic units, etc., involved will retain the required values and remain operable under the temperatures to be encountered, temperature control is indicated.
2. Determine the maximum permissible temperature variation of the component part or device to be controlled.
3. Where an individual part is involved, provide for intimate contact between the part and thermostat so that the latter can quickly sense any change in the former's temperature. If actual contact between the two is impractical, place them as close together as possible. Mounting both part and control on a common metal strip or plate will often provide an efficient thermal path between the two.
4. Mounting the thermostat directly on the part permits the use of a control whose differential is equal to the permissible temperature variation of the part. When the part and the control are separated, a time lag occurs between any change in the temperature of the part and the resultant change in that of the control. This time lag is a function of both the distance between the part and thermostat, and the efficiency of the thermal path between the two. Unless compensated for, such lag introduces temperature overshoot and undershoot, which is known as "flywheel effect." Compensation may be effected by using a thermostat with a smaller differential.
5. It is sometimes necessary to control the temperature of a number of components within an enclosure. In such a case, find that area in the enclosure where the rate of temperature rise or drop is greatest, and locate the thermostat in that area. The optimum location for the control may be self-evident. Again, determining such location may involve the taking of temperature readings in various portions of the enclosure while it is subjected to actual or simulated ambient conditions.
6. Most thermostats are available with an integral mounting device, such as a flange or threaded bushing. Where no mounting device is provided, as in certain expanding-shell controls designed for insertion in a metal block, the thermostat may be clamped to the part or device it is to control. Care must be taken not to tighten the clamp excessively, since this will deform the comparatively thin metal shell. Also, the use of a single clamp is preferred so the necessary linear expansion and contraction of the shell will not be restricted.

Thermostat Design

Since thermostatic controls are available in a wide variety of characteristics, sizes, mountings, etc., it would be senseless in most instances for the equipment engineer to design and build his temperature controls. If his application requires the extremely fast action of the bimetallic disc, or the very precise control of the expanding-shell or mercury types, he has little choice but to select one

Table 2—Thermostat Design Characteristics

Type	Action	Minimum Differential (deg F)	Maximum Current Capacity (amp)	Maximum Temperature Range (deg F)	Approximate Cost (dollars)
Bimetallic Strip	Slow make-break	0.1	8	— 60 to + 600	4
Bimetallic Disc	Snap action	10	45	— 60 to + 600	5
Expanding-Shell	Slow make-break	0.1	25	—100 to + 600	10
Mercury	Slow make-break	0.5	0.1	— 65 to + 600	25

Notes:
1. Current-capacity values are based on 115 v ac. Unless control is hermetically sealed and inert-gas filled, these values should be derated.
2. Differential, current, temperature, and cost values shown are merely representative, and do not necessarily apply to all thermostats within a particular type.
3. Hermetically sealed versions of all of the types listed are available.

of these types of thermostats. If, for some reason, none of these types is acceptable, and if the characteristics of the bimetallic strip thermostat are satisfactory for his application, then it is quite feasible for him to construct a thermostat to suit his needs. The following example illustrates how such a thermostat is designed.

Example Problem: Determine the active length of a bimetallic strip, which is 0.05-in. thick and fastened at one end, that will deflect 0.1 in. for a change in temperature from 50 to 150 F.

SOLUTION: Reduced to its simplest terms, the formula for determining the deflection of a bimetallic strip, clamped at one end (cantilever), is

$$B = \frac{C\,L^2(T_2 - T_1)}{t} \qquad (1)$$

where B = deflection, in.; C = thermal-activity or deflection constant; T_1 = initial temperature, F; T_2 = final temperature, F; L = active length of strip, in.; and t = thickness of strip, in.

Since the problem requires a determination of the active length, L, of the bimetallic strip, certain terms in Equation 1 must be transposed and the square root of both sides taken, or

$$L = \sqrt{\frac{Bt}{C(T_2 - T_1)}} \qquad (2)$$

Note that the width of the strip does not enter in the calculations. Also, since the loading effect of the electrical contact on the strip is negligible, it has been omitted. The larger the thermal-activity constant C, the smaller will be the required strip length for a given deflection, thickness, and temperature change. The first step, then, is to find a bimetal with a large thermal-activity constant. This requires a study of curves of thermal-activity constants versus temperatures of various bimetals; these are readily available from bimetal manufacturers. Besides thermal activity, the resistivity and maximum sensitivity temperature range of the bimetal must be considered. Assume that a thermal-activity constant of 78×10^{-7} is chosen after these several factors have been evaluated. Substitution of the known values in Equation 2 gives

$$L = \sqrt{\frac{0.1(0.05)}{78 \times 10^{-7}(150 - 50)}}$$

$$= 2.5 \text{ in.}$$

Thus, a bimetallic strip of material of the type chosen that is 2.5 in. long (active length), 0.05-in. thick, and any suitable width will deflect 0.1 in. for a 100 deg F change in temperature.

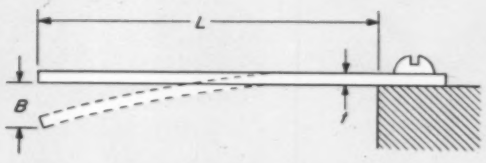
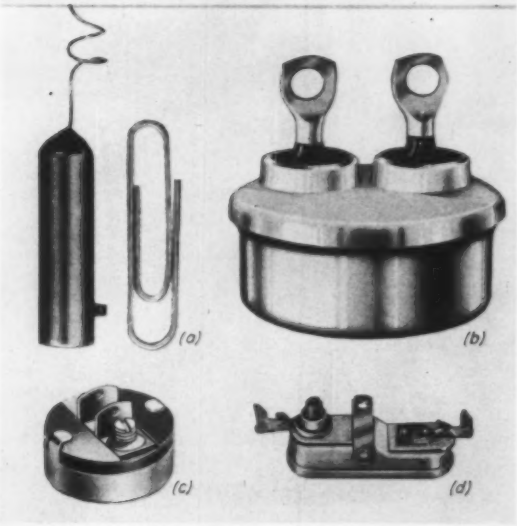


Fig. 7—Above—Dimensions required to design a cantilever bimetal strip

Fig. 8—Below—A variety of miniature thermostatic controls. Four of the many thermostat manufacturers are represented: Edison *(a)*, Spencer *(b)*, Fenwal *(c)*, and Ulanet *(d)*. Many of these miniature units are sealed for use under adverse environmental conditions. Compromises in performance are necessary to obtain small components



▶ Miniature Designs

The increased complexity of electronic equipment has resulted in a demand for small-size components. Manufacturers of thermostats have spent considerable time and money miniaturizing these controls. The small size of such thermostats, when used with either miniature of flexible heater elements or with midget blowers, qualifies them for use in guided missiles, aerial cameras, and a host of other applications where space is at a premium. Typical miniature thermostats are shown in Fig. 8.

As might be expected, this reduction in size is not obtained without some sacrifice in performance. In certain cases, considerably wider differential must be accepted; in other instances, a much smaller current rating. For example, while the larger Spencer disc thermostat has a minimum differential of 10 deg F, that of their miniature unit is 25 deg F. Again, the Fenwal large-size expanding-shell control has a current rating of 25 amp at 115 v ac; their miniature control (not of the expanding-shell type) is rated 3 amp at 115 v ac.

Certain of these miniature thermostats, as well as some of the larger units, are hermetically sealed. Thus they are suitable for operation under adverse environmental conditions such as salt or dust-laden air, explosive atmosphere, or high relative humidity.

ACKNOWLEDGMENT

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Design details of a

Spring-Loaded Differential Drive

for automatic tensioning and take-up in reel mechanisms

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SPRING loading the spider gear in a differential gear train suggests a practical solution to problems in the handling of reels of tape, film, or wire where it is desirable to have a single drive point, automatic tensioning, and slack take-up without clutches or brakes. In the design shown in Fig. 1, two in-line reels are driven from a single drive point. Difference in reel speeds due to variations in diameters of tape coils is absorbed by the spider gear orbiting in the differential train. A spring load is applied to the spider gear, tending to make it orbit in a clockwise direction. The spider now acts as a fulcrum when the crank is turned in a clockwise direction. Force is transmitted through the differential to the chain and thus to reel *B*, pulling the tape across from reel *A*. The spring also provides automatic tensioning of the tape in either direction of tape movement.

This mechanism has been used on an ultrahigh-resolution potentiometer, Fig. 2. The tape was a metallic resistance ribbon backed with a layer of pressure-sensitive insulation. A Hunter N'egator B-motor was used as a constant-tension spring acting through a set of gears.

Number of revolutions of the spider and other factors of the mechanism can be calculated from

$$R_o = \sqrt{\frac{LT}{\pi} + R_i^2}$$

$$X = \frac{\pi}{4TR_i}(R_o^2 - 2R_i R_o + R_i^2)$$

where R_o = minimum reel radius; R_i = reel hub radius; L = length of tape; T = tape thickness; and X = number of spider revolutions. All dimensions are in inches.

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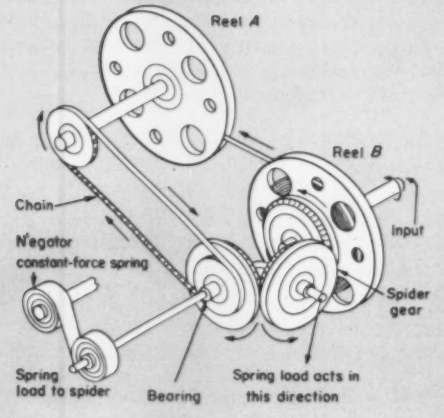
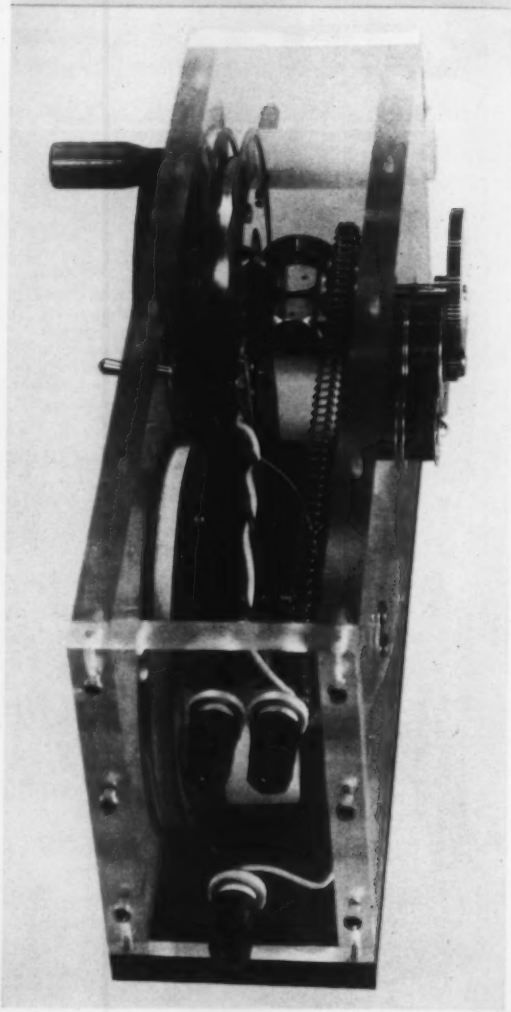


Fig. 1—Above—Tape reeling mechanism showing details of spring-loaded differential drive assembly

Fig. 2 — Below — Ultrahigh-resolution potentiometer employing spring-loaded differential drive



By **HAROLD A. DASCHNER**
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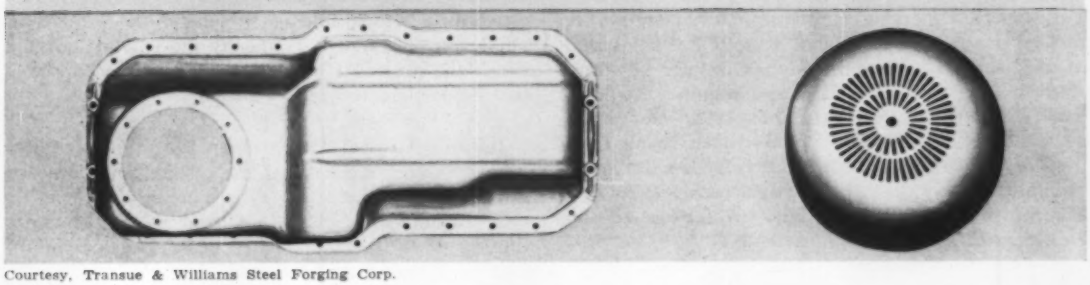
Some practical pointers for

Designing Low-Cost Stampings



Courtesy, Transue & Williams Steel Forging Corp.

Those who estimate stamping costs, design and build dies, and supervise production know many ways in which the cost of the average stamping could be reduced. Based upon accumulated experience of members of the Pressed Metal Institute, this article is a practical checklist for cost-conscious stamping designers.

ONE OF THE most costly practices in stamping design is incorrect or unnecessary specification of dimensions and tolerances. This usually results from not determining what is actually required and then specifying these requirements on the drawing. In such cases, as the part print is studied during estimation of production costs and planning of dies, questions arise whether radii need be as sharp as shown, if all holes require the same tolerances, or how square the bends must be. All too often, when these questions are asked of the designer, it is decided that some radii can be less severe, only part of the holes require precise diameters or locations, and only reasonable squareness is expected of the bends. As such requirements are made less stringent, tooling, production, and total costs are reduced—sometimes dramatically.

Clever die designs fill textbooks, many of them merely monuments to poor stamping design. No matter how poorly designed, a stamping can usually be produced, but the resultant cost may be entirely unjustifiable. This is because of the extra operations that may be required to provide extreme accuracy or produce complex shapes. Each additional operation adds to processing costs and die investment and maintenance, and is reflected in the final cost of the stamping.

The designer can have almost anything he wants —if he is willing to pay for it. Specifying anything

more expensive than necessary to achieve the required end result is poor design practice.

Stampings enjoy a cost advantage over parts made by most production processes, but improper design can largely nullify this advantage. Some errors in stamping design are made quite commonly; all of them add to the cost of the part. These more common errors and omissions include lack of technical familiarity with the stamping process; selection of empirical radii, dimensions, and tolerances; and simply not thinking the design through. Points to consider in design of low-cost stampings fall into a few general groups.

Try To Combine Processes: Assemblies can frequently benefit by combining stampings with other parts, such as forgings or castings. The technique of combining components produced by different processes is very important and should be explored when working with large or complex shapes.

Watch Out for Pierced Holes: Holes, especially threaded holes, frequently disappoint the designer. Walls of holes taper, wide diameter tolerances may be needed, close center tolerances may require an extra operation, and distortion is usually present if holes are near a bend or draw area. Whenever possible, on slightly curved surfaces or nearly parallel planes, permit piercing all of the holes at once with parallel punches, even though some of the holes will be oval shaped. When in doubt, consider how the holes will be produced. If a part requires extruded holes for threading, the extruded portion cannot be expected to increase the thread length much over 50 per cent of the material thickness. Do not specify more threads than the physical properties of the material will permit, especially in low-carbon or stainless steel.

Tell What the Part Is For: Give as much end-use data on the print as possible. If the part is covered and not exposed to view, less expensive material finishes may be utilized. Parts to be painted or plated should indicate whether this finish is for decorative, protective, or other purposes. The applied finish may limit the as-purchased mill finishes that can be employed. If end-use data are provided, suggestions from production and tooling personnel are likely to be of considerable value in trimming production costs.

Select the Right Material: Too frequently, designers tend to specify favorite materials with which they are familiar. All too many prints specify only "H.R.P.O." or "C.R.S." Perhaps there is another metal that will make a better part or lower the cost. In any case, a very wide range of materials and finishes can be supplied under a blanket specification such as "cold-rolled steel." Only one combination of material and finish will give the best price for a given part, quantity, and set of tooling. Select and specify that proper combination.

Specify Cleaning if Necessary: State whether drawing compounds, shop oils, dirt, etc., are to be removed. If parts will not be in storage long, only a light oil should be left on them. If parts may be in storage for some time, heavy oils and drawing compound are best left on to help prevent rusting.

Avoid Problems from Samples: Samples furnished with a print should be of the proper material. When a sample is provided, proper specification of material required is extremely important and should be stated with sufficient prominence and clarity to eliminate being unnoticed. If the note, "make like sample" is used, be certain that it is meant.

Keep Up with Material Developments: Precoated metals, available with paint, plating, and plastic coatings, are excellent cost-cutting possibilities. Plastic parts can be combined with stampings where strength requirements and temperature conditions permit, frequently resulting in less expensive components than by stamping alone.

Check Prints for Clarity: Occasionally an incorrect projection is made on a print, leading to all kinds of misunderstanding. If there may be any doubt as to which side of the piece should have the bend, burr, extrusion, or countersunk hole, be sure sufficient clarification is given. Be certain that dimension lines are drawn clearly to avoid questions concerning which side of the metal the dimension applies to. Although it means more work, double check the drawings to see if any misunderstandings can be anticipated and clarified.

Indicate Critical Dimensions: Only the designer knows which dimensions are critical. If all are critical, this should be clearly designated, but if only certain dimensions are vital to proper functioning of the part, indicate them. Do not specify blanket dimensions or tolerances to cover an entire part. For economy, mark noncritical, nonfunctional dimensions as such and permit wide tolerances.

Dimension all holes when dimensions are necessary for fabrication of the stamping, but do not dimension holes that have no value to the stamper, such as drilled holes, or hole sizes produced after stamping by drilling, reaming, or countersinking. Give only stamping dimensions on a stamping print.

Specify Proper Material Thickness: This thickness is not necessarily the same as was used for the last part designed. Do not apply less-than-mill tolerances to thickness at critical points unless cost of a coining operation or later machining is acceptable. Specify thickness by gage or decimal equivalent—do not use fractions.

Use Care in Specifying Flatness: Flatness is a matter of the designer's ability to create a part that can be made flat. Even though the phrase, "part must be flat" is frequently found in specifications, absolute flatness is usually impossible due to shape, material properties, and stresses inherent in material that has been cold formed. If flatness is imperative, it can usually be provided to a degree by coining, straightening, or secondary forming opera-

tions, but costs go up. On some materials, particularly brass, warpage of the part may become noticeable months after the part was run and flatness approved.

Plan on Heat-Treatment Distortion: When a high-precision part is designed to require heat treating, beware of distortion and consequent changes in tolerances. If such a design is necessary, plan on additional operations to conform the piece to specifications and tolerances.

Use Realistic Tolerances: Remember that the producible tolerances of features on stampings must be selected in relationship to the material thickness. When hole tolerances are not specified, industry-standard tolerances are applied, Table 1. For hole

Table 1—Tolerances for Pierced Holes

Material Thickness (in.)	Tolerance (in.)				
	Hole Diam: to 1 in.	1 to 3 in.	3 to 10 in.	10 to 20 in.	over 20 in.
Up to 0.015	±0.0015	±0.003	±0.004	±0.006	±0.008
0.015 to 0.031	0.003	0.004	0.005	0.008	0.010
0.031 to 0.062	0.004	0.005	0.007	0.010	0.015
0.062 to 0.125	0.010	0.012	0.015	0.020	0.025
Over 0.125	±0.020	±0.025	±0.030	±0.035	±0.040

Values given are for low-carbon steel

dimensions, try to use standard punch sizes, available in increments of 1/64 in. If nonstandard punches are necessary, costs are higher and production delays from broken punches are longer.

Always specify angles in degrees, not in decimals. Tolerances range from ±30 sec to ±1 deg 30 sec. Springback is controlled, to the extent demanded by the print, by proper tooling. Sometimes additional operations are involved, however, so to achieve lowest costs where angle of bends is not critical, give loose angular tolerances or a note that springback is acceptable.

Bending radius must be not less than metal thickness on bends of 45 deg or over, and not less than 1/64 in. in any case. The actual radius is determined by the temper of the material. Sharp-radius bends increase die wear and may increase scrap rate, but do tend to reduce springback on many materials.

Radius on bottom of deep-drawn cups should be not less than metal thickness for shallow draws, and not less than twice metal thickness for deep draws. On the latter, if a smaller radius is necessary, a restrike operation is required. Taper on walls of deep-drawn shells depends upon size, shape, and tolerance specifications. A frequent tolerance is ±0.005 in. per in. of shell height. Drawn cups will not have a uniform wall thickness; the wall is thinner than original thickness at the bottom of the cup and thicker than original at the top. Taper tolerance given above applies only to inside of the wall.

Specify concentricity tolerances only when necessary for proper functioning. Usual concentricity tolerances provided are within 0.040 in. TIR. Slitting tolerances are from ±0.003 to ±0.015 in., depending upon thickness of material. Blanking provides ±0.002 to ±0.010-in. tolerances, and shearing ranges from ±1/64 in. to ±1/32 in. at 1/8-in. thickness and is ±1/16 in. at thicknesses over 1/8 in.

Keep gaging requirements in mind and avoid configurations or dimensions that are difficult to gage. Intricate gages are expensive and both their cost and use are included in the stamping cost.

Avoid Excessive Burr-Removal Requirements: Since there is little agreement in the stamping industry as to what constitutes a burr, it is always wise to specify exactly what you will accept. Deburring can include anything from just keeping shearing and punching edges in the die sharp or manually knocking off sharp edges on the stamping, to special grinding operations. To obtain what you want at a reasonable price, do not use the expression, "free from burrs" too loosely. The usual practice is to accept a burr up to 0.1-metal thickness in height.

Tips and Techniques

Roots of High Degree

Many approximate formulas for the determination of square and cube roots have been proposed. However, for higher degrees, a useful equation is

$$\sqrt[m]{N} = \frac{a[(m-1)a^m + (m+1)N]}{(m+1)a^m + (m-1)N}$$

where N = number of which the mth root is desired and a = an approximate value of that root.

Example: Find the fifth root of 30, where $N = 30$ and $M = 5$; a can be taken as 2. Then,

$$\sqrt[5]{30} = \frac{2(4 \times 32 + 6 \times 30)}{6 \times 32 + 4 \times 30} = \frac{77}{39} = 1.9743$$

If the process is repeated, now taking $a = 1.97$, the equation yields

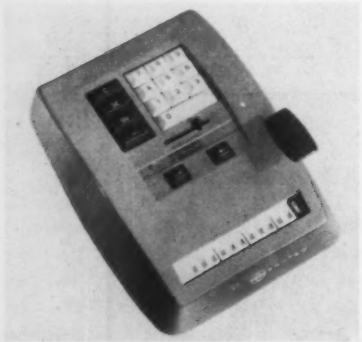
$$\sqrt[5]{30} = 1.9743504$$

This is a better approximation than would have been obtained with a five-place logarithm table.—PIERRE ACHENER, *Walnut Creek, Calif.*

Low-Cost, Mechanical Calculator

SIMPLIFIED ACTUATING PRINCIPLE permits operating a new all-mechanical calculator at speeds equal to or exceeding those of electric machines. As reported by Leon Bohn, president, Bohn Duplicator Corp., New York, it is not necessary to remove the fingers from the keyboard to operate the actuating bar on their BDC Contex.

Just 10 in. long, 7 in. wide, and 3¾ in. high, the ten-key automatic fits into a desk drawer or briefcase.



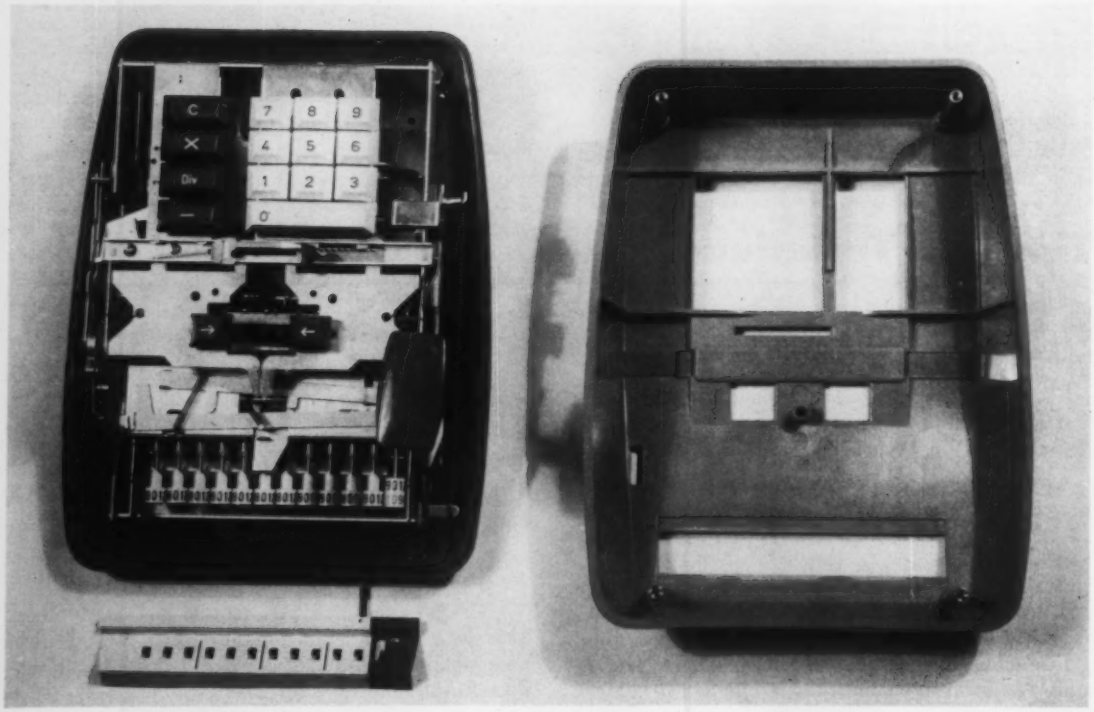
NINE UNITIZED SUBASSEMBLIES make up the complete calculating mechanism. This design approach allows quick and easy removal of any subassembly, for replacement or repair, by loosening only one or two screws.

Housing and mechanism for the machine were both designed by Henning Carlsen of Copenhagen, Denmark. In describing his design objectives, Mr. Carlsen said, "The target we had in view when designing the Contex was to create a calculator that was well in advance of the trend of developments. . . .

"It would have to be small . . . be quick and simple to use. It should sell at a price low enough to make it possible for every person in the office to economically afford a machine for his personal use.

"The Contex is built on new design principles, and together with the reduction of size of the parts, it was possible to meet the [design] objectives.

"The styling of the machine was primarily dictated by the convenient positioning of the keys with a view to a practical and handy operation of the machine. . . . Styling of the machine is a matter of taste, to which it is difficult to give expression. . . . I have aimed at a compromise between too rigid and too soft lines, with the target being to have the exterior form a simple, homogeneous housing where the surfaces provide cover and support for the mechanism and, if possible, esthetic satisfaction to the user."



Attains Electric Machine Speeds

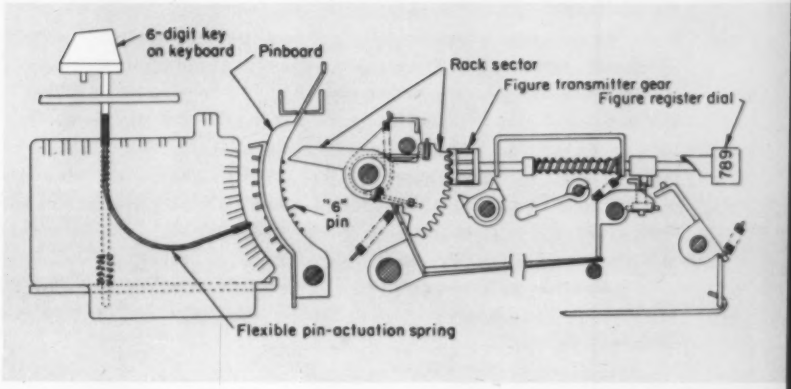
MECHANISM DESIGN SIMPLICATIONS were applied throughout the machine to reduce the number of parts as well as part size and weight.

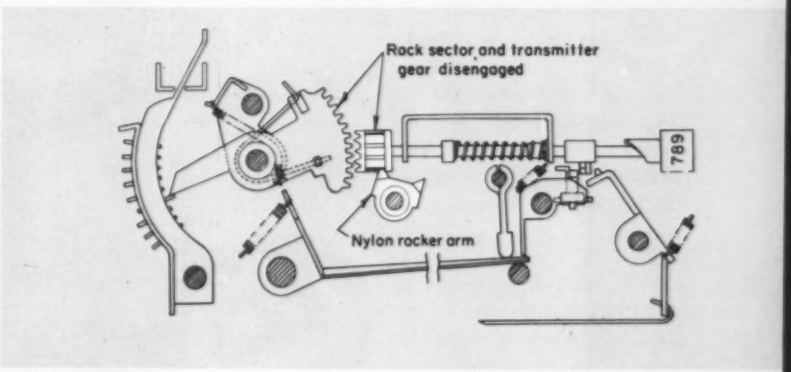
Transmitting the digits from the keyboard to the pinboard is accomplished by a simplified assembly. Basically, this unit is a plastic block in which channels are provided for flexible pin-actuation springs. Each pin in the pinboard determines how far the rack sector is allowed to come down and, in turn, which number will be entered on the figure register dial when the rack sector returns to its original position.

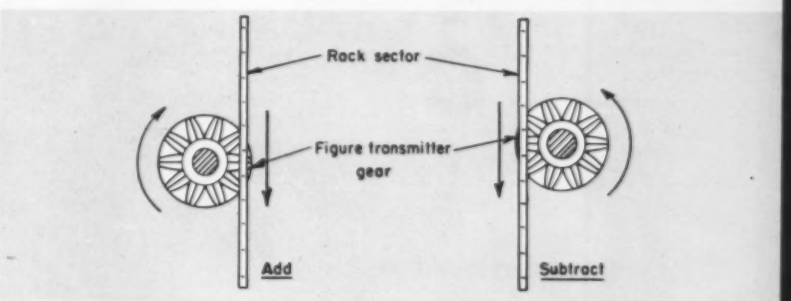
AUTOMATIC DISENGAGEMENT between rack sector and transmitter gear is required while the figure being entered into the machine is setting the rack sector for proper stroke. This function is accomplished by a series of nylon rocker arms which disengage the rack sector and transmitter gear on the downstroke of the actuating bar and engage them on the upstroke.

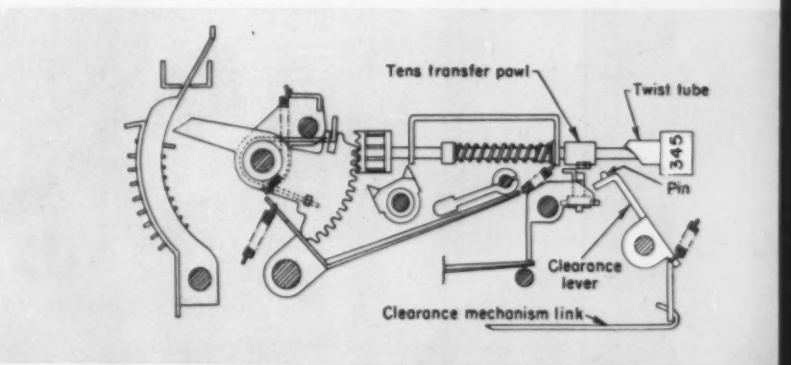
ONE GEAR INSTEAD OF TWO are used in each transmitter assembly for both addition and subtraction operation. To add, the transmitter gear engages the rack sector from the right side. Since subtraction requires that this gear turn in the opposite direction, the whole transmitter assembly for all columns is moved to the left side of the transmitter gear.

PUSHING THE REGISTER-CLEARANCE key operates the clearance mechanism link and pulls the clearance lever in the direction shown. A pin at the end of this lever engages a cam surface on the edge of the twist tube portion of the register wheel, turning it to the zero position.









Expansion Forces of Freezing Brine

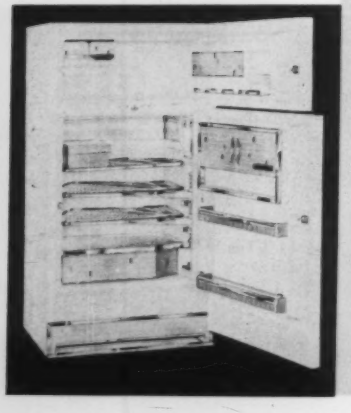
ICE-REMOVING EXPANDER assembly is attached to movable grids within the tray assembly. The expander is essentially a stainless-steel cylinder equipped with a plunger and filled with brine, which freezes at a lower temperature than ordinary water. When the water in the tray has formed ice cubes, the brine solution within the expander device starts to freeze. Expansion of the brine, as it freezes, exerts more and more pressure on the plunger which moves outward, causing the grids to move from their normal position to an expanded position. This action breaks the ice cubes loose.

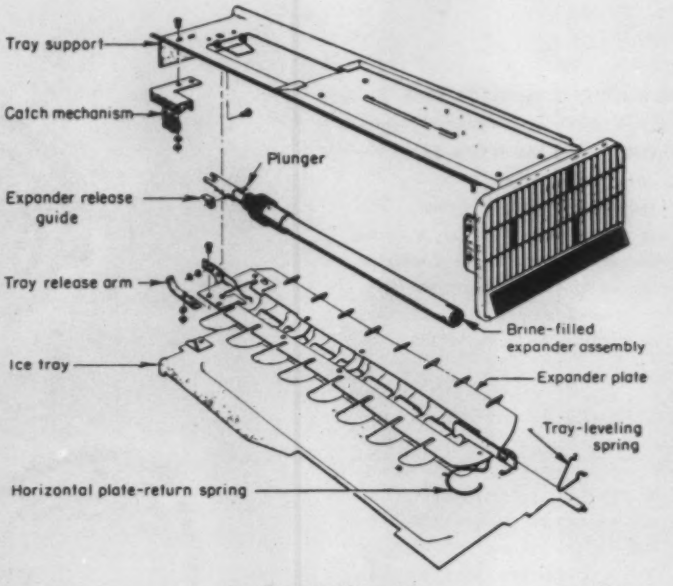
Travel of the plunger continues as the brine freezes, moving the grid assembly and causing a lever to contact a cam on the tray assembly. This movement forces the tray to drop down and release the ice cubes.

A lever on the plunger rides up a stationary cam until it reaches a point where the expander pressure is released from the grid assembly. At this point, a spring snaps the grids back to normal position, knocking any cubes loose that might still be hanging up within the grids.

Refilling the ice-cube tray with water will thaw the brine solution, allowing an internal spring within the expander assembly to bring the plunger back to normal position.

AUTOMATIC ICE-CUBE maker in 1958 Norge refrigerator makes use of a novel expander assembly. Located in the freezer compartment, the Handi-Cube ice maker automatically releases and stores a supply of 108 dry, separated cubes. The shelves in this new machine swing out and are adjustable in height.



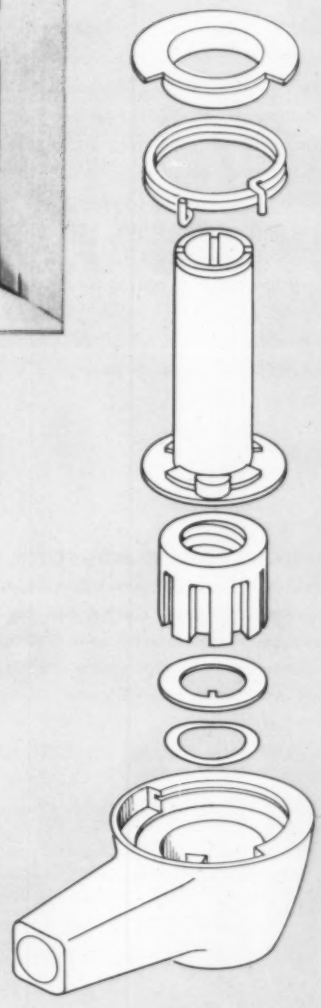


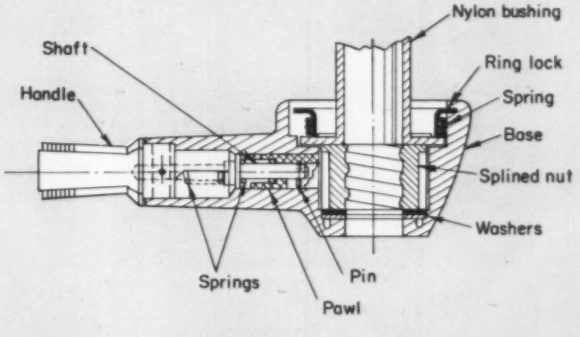
Ice Removing Expander

Ice-Cube Grid in Normal Position

Ice-Cube Grid in Expanded Position

Automatically Remove Ice Cubes





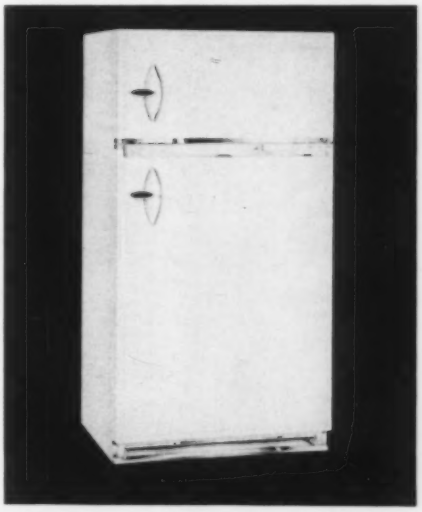
SWING-OUT SHELVES are fitted over shelf supports, which are mounted to a recessed threaded shaft. The shelf supports are in turn supported by ratchet mechanisms, which are keyed to the shaft. The shaft is held by three brackets to the cabinet liner with screws driven into a tapping plate.

To raise or lower a shelf, the knob on the ratchet-operating handle is twisted either 90 deg clockwise or counterclockwise, depending on desired direction of movement. Then the handle is oscillated through a 112-deg angle.

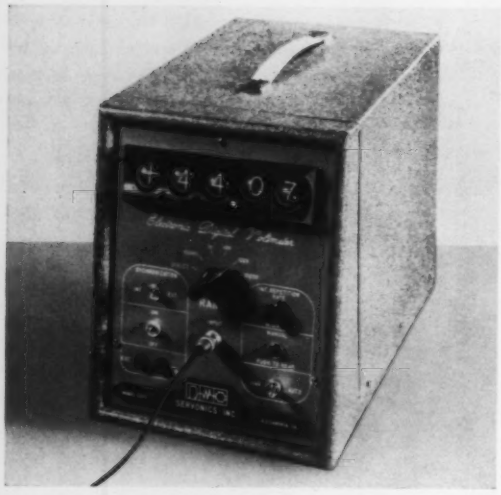
The ratchet mechanism consists of a splined nut on the threaded shaft. A pawl in the handle portion engages the splines and turns the nut on the shaft. Springs are provided to return handle and knob to neutral positions when desired height on shelf is attained.

A nylon bushing connects the shelf support to the ratchet mechanism, and provides a bearing for the swing-out shelf support.

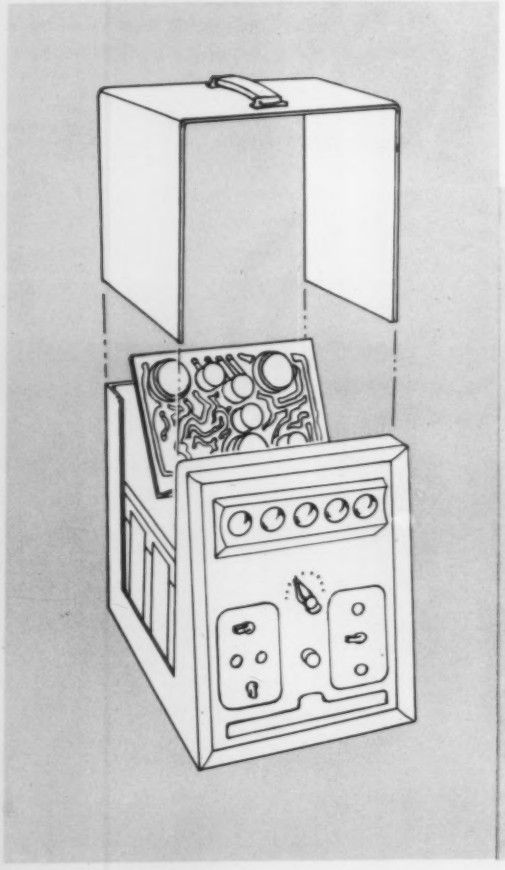
SHADOW-BOX EFFECT for the door exterior is achieved by a recessed border. An interior shadow-box effect is created by recessed appointments in the main compartment and correspondingly deep design of the door interior.



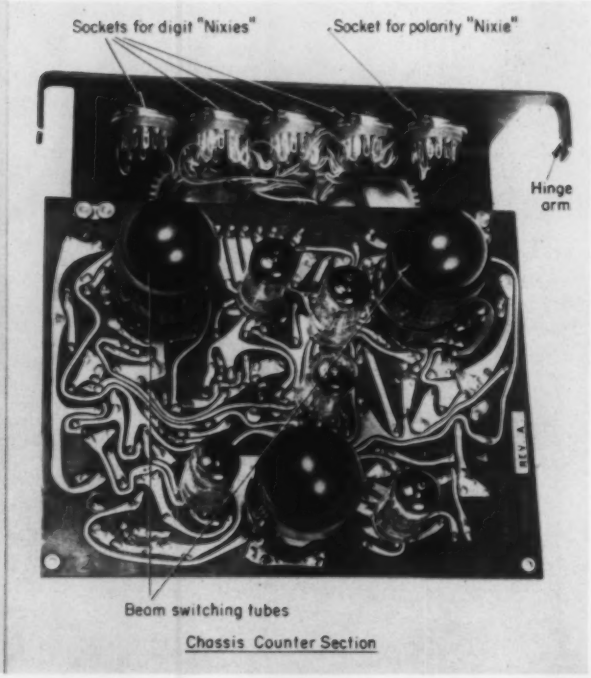
Good Appearance, Accessibility, and Readability Are Meter Design Keynotes



SLOPED FRONT-PANEL DESIGN in a new electronic digital voltmeter makes controls easier to operate and numbers more visible. Designers F. William Wood Jr. and Thomas R. Smith, Servonics Inc., styled and designed the instrument package with the objective of avoiding the more common "boxy" appearance. This was achieved with the sloping case front, the recessed control-and-readout panel, and rounded case contours. The concave flat-black readout mask reduces external glare and provides a contrasting background for easy readability. The mask also gives the meter an appealing three-dimensional effect. The in-line visual-readout number Nixies are easily read at a distance of 30 feet.



INTEGRAL TOP-AND-SIDES COVER, held on by six screws, makes instrument servicing simple. With this cover removed, the main chassis can be hinged up, providing maximum accessibility to all circuits while testing with power on. Printed wiring boards are used throughout.



Chassis Counter Section

JIC Graphical Symbols

Control, manual	MAN
Control, pilot hydraulic	HYD
Control, solenoid	SOL
Cylinders, double acting Single end rod	
Double end rod	
Line, drain	-----
Line, pilot	— —

Line, working	———
Line, to reservoir	
Motor	MTR
Pressure gage	
Pressure switch	PR SW
Pump, fixed displacement	PF
Reservoir	
Spring	

Strainer	STRN
Valve, check	
Valve, manual shutoff	
Valve, max pressure	
Valve, 2 position, 4 connection	
Valve, 3 position, 4 connection	
Valve, sequence	

SEQUENCING HYDRAULIC CIRCUITS

By H. L. STEWART and J. M. MORITZ
Logansport, Ind.

There is no shortage of hydraulic, pneumatic, mechanical, and electrical components that can be combined to provide sequence control in a hydraulic circuit. Chief problem of the designer is to select the minimum number of control elements that will do the job efficiently and economically. A variety of possible circuits, with their pros and cons, are presented here.

SEQUENCE control in a hydraulic circuit forces cylinders to actuate in a predetermined order. Whether automatic, semiautomatic, or manual, sequence controls are usually triggered by one of the following actions: 1. Pressure change in some part of the circuit. 2. Change in the position of a mechanical component. 3. Time from a preceding event. 4. Manual signal from the operator.

The designer acquainted with basic sequencing methods is limited only by his ingenuity in laying out the most economical and efficient control combination for his application. Operation of the more common sequencing circuits, together with pertinent design precautions, are presented in this article.

Sequence-Valve Circuits

One of the simplest methods for sequencing movement of two or more cylinders is by use of sequence

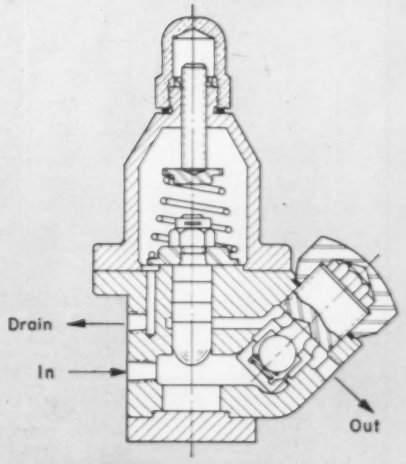


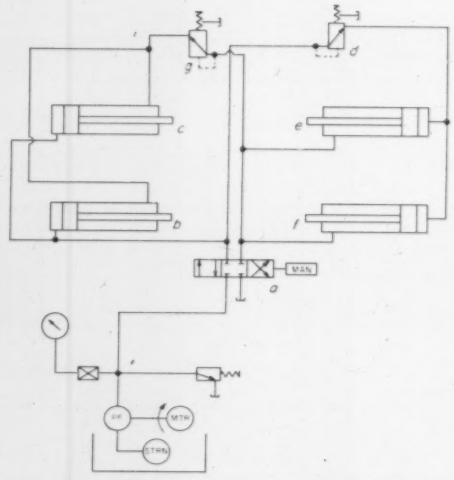
Fig. 1—Sequence-valve cross section. Although outwardly similar to the spring-loaded relief valve, the sequence valve differs in that a drain is provided in the spring chamber. Function of the drain is to relieve back pressure on the valve plunger, thereby avoiding throttling or reducing action as outlet pressure builds up. Check valve permits reverse flow for oil return from cylinders. Sequence valves may be either direct operated or piloted types and are supplied in various pressure ranges.

valves, Fig. 1. Advantages of this system are reduction in piping, small component size, and economy. Basically, the sequence valve is related to the spring-loaded relief valve. Since the sequence valve is designed to open only after the applied pressure increases to a preset level, it is not applicable where the operating pressure of the second cylinder must be lower than that of the first. Operation of a clamp-form circuit using sequence-valve timing is described in Fig. 2.

Disadvantages of the sequence-valve system are that it is not completely positive and that a jam in some part of the mechanical system may damage the mechanism. For example, results can be disastrous if blockage occurs in the double-transfer arrangement shown in Fig. 3.

Assuming that the load is jammed in path *A*, pressure builds up in cylinder *a* and releases the second transfer cylinder, c. Piston rod c then moves out and, should the jam clear, the load will move to path *B*. The piston rod and transfer mechanism of the second cylinder are then likely to be damaged. In general, where there is possibility of unscheduled pressure buildup, sequencing by pressure controls is not recommended.

Many variations of the basic sequence-valve circuit shown in Fig. 2 can be worked out. If, for



1. Operator shifts handle of three-position, four-way valve *a*, allowing oil to flow to blind ends of clamp cylinders *b* and *c*. Pistons *b* and *c* advance, clamping workpiece in fixture.
2. Oil pressure then builds up, opening sequence valve *d* which sends oil to blind ends of forming cylinders *e* and *f*. Pistons *e* and *f* move forward and carry out the forming operation.
3. To retract forming-cylinder pistons, operator shifts handle of valve *a* to return position, sending oil to rod ends of cylinders *e* and *f*.
4. Pressure builds up and opens sequence valve *g*, directing oil to rod ends of clamp cylinders *b* and *c*. Pistons retract to complete cycle.
5. Operator shifts valve *a* to neutral position, allowing oil to spill back to reservoir during standby.

Fig. 2—Basic clamp-and-form hydraulic circuit incorporating sequence valves. Reverse-flow capability of sequence valve *g* allows oil to flow to reservoir when clamping pistons *b* and *c* extend.

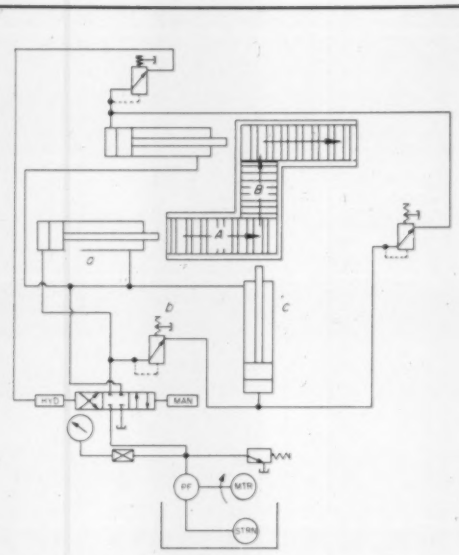
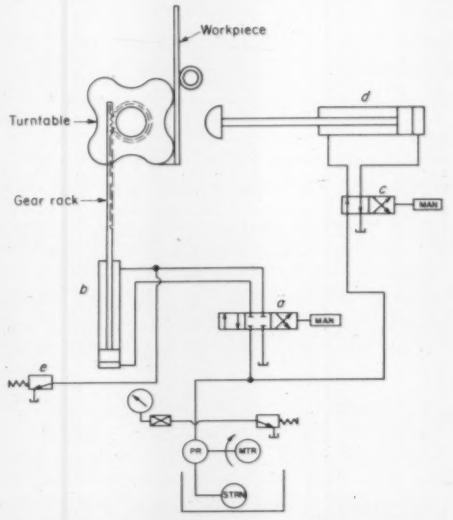


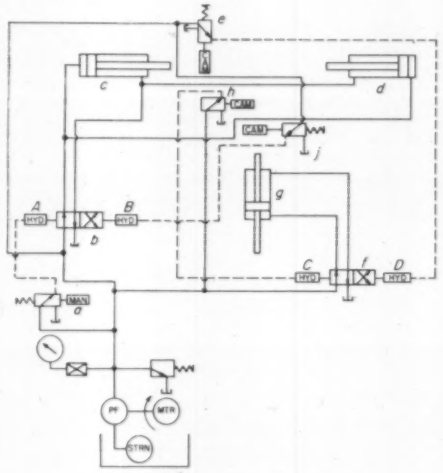
Fig. 3—Application of sequence valves in the manner shown here in a double-transfer circuit is not recommended. Danger lies in the possibility of unscheduled pressure buildup on the blind side of cylinder *a* due to blockage of the workpiece in path *A*. Result is actuation of sequence valve *b* which extends the second transfer cylinder, *c*. Should the blockage clear, cylinder *c* may be damaged.



1. After positioning workpiece in die, operator shifts handle of three-position four-way valve *a*, directing oil to blind end of turntable cylinder *b*. Piston advances part way and indexes turntable 90 deg.
2. Operator shifts valve *a* to neutral and shifts four-way, two-position valve *c* to send oil to blind end of forming cylinder *d*.
3. When workpiece is formed, operator moves handle of valve *c*, retracting forming piston.
4. Operator shifts valve *a*, indexing turntable another 90-deg increment, and then returns valve to neutral.
5. Valve *c* advances forming piston. Procedure is repeated until four sides of workpiece are formed. Valve *a* then retracts turntable piston to starting position.

Fig. 4—Multiple manual-valve sequencing circuit. To prevent overheating of oil during the standby period, maximum-pressure valve *e* is incorporated to provide drain to the reservoir.

example, semiautomatic operation is desired, a solenoid-operated four-way valve can be substituted for the manually operated valve, *a*. A photocell or pressure switch, either of which can trigger a relay, may be used to send an electrical signal to the solenoid valve after pistons *e* and *f* have reached their outstroke positions. By means of a timer, the three-position valve can then be moved to the neutral position after all motion stops. Such semiautomatic circuits can be made completely automatic by actuating the solenoid of the four-way valve with a switch operated by contact with the workpiece.



1. Operator actuates three-way, spring-offset pilot control *a*, sending oil to pilot connection *A* of valve *b*. Spool of valve *b* shifts, directing oil to blind ends of cylinders *c* and *d*. Pistons *c* and *d* clamp workpiece in fixture.
2. When piston *d* reaches end of stroke, it actuates cam valve *e*, directing oil to pilot *D* of valve *f*. Spool shifts and sends oil to blind end of broach cylinder *g*, performing the broaching operation.
3. Piston *g* actuates cam valve *h*, directing oil to pilot *C* of valve *f* and shifting its spool to the original position. This directs oil to rod end of broach cylinder *g*, retracting the broach piston.
4. As broach piston *g* nears end of stroke, cam on valve *j* is actuated momentarily and oil flows to pilot connection *B* of valve *b*. Spool shifts, sending oil to rod ends of cylinders *c* and *d* and retracting the clamp pistons.

Fig. 5—Pilot-operated valves, with either hydraulic or pneumatic pilot actuation, have application in explosive atmospheres where electrical components are undesirable. Sequence circuit shown here, designed for clamp-broach operation, combines cam-operated valves with hydraulically operated pilot valves. Cams for actuating cam rollers are of the swing type so as to actuate in only one direction.

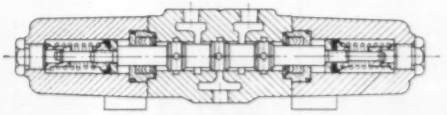


Fig. 6—Pneumatic-pilot four-way valve. Use of the pilot-operated valve in sequence circuits simplifies the interlock arrangement and eliminates long runs of high-pressure tubing.

▶ Manual Sequencing

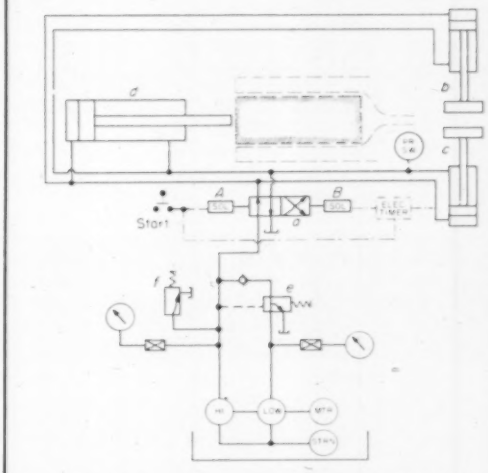
Sequencing by manually operated controls may have advantages over automatic techniques in certain applications, Fig. 4. It is claimed, for example, that the operator gets a better "feel" of what is taking place in the cycle. Another advantage is that inching operations can be easily carried out.

In the usual manual-sequence circuit, there is danger that the operator may mix up his sequence. The circuit designer can eliminate this possibility by incorporating linkages to insure that a given valve handle cannot be operated until other valves are properly positioned.

▶ Pilot-Valve Sequencing

Hydraulic pilot-controlled sequence circuits have application where explosive atmospheres may rule out the use of solenoids, limit switches, pushbuttons, and similar electrical components. Chief objection to pilot controls is that they require considerably more piping than direct systems. In addition, piloted components are more bulky than other types.

Initial operation of pilot-controlled sequencing cir-



1. Operator momentarily depresses start button, energizing solenoid *A* of four-way valve *a*. Oil is directed from both high and low-pressure pumps to blind ends of closing cylinders *b* and *c* and extrusion cylinder *d*.
2. When pistons *b* and *c* extend fully, pressure builds up and unloading valve *e* spills the low-pressure pump flow back to the reservoir. High-pressure pump continues to supply oil to extrusion cylinder *d*, which then advances to perform the operation.
3. Electric timer energizes solenoid *B* of valve *a*, shifting its spool to the original position. Pistons of cylinders *b*, *c* and *d* then retract under low pressure.
4. Pressure again builds up, spilling oil from low-pressure pump to reservoir through valve *e*. System is under high pressure during standby, with flow spilling through relief valve *f*.

Fig. 7—Sequence circuit for extrusion apparatus employing high-low pressure pump arrangement. System has advantages where both light and heavy-duty cylinder actuations are required.

cuits can be initiated by either manual or automatic means. For automatic operation, cam valves are generally employed. A representative circuit is shown in Fig. 5.

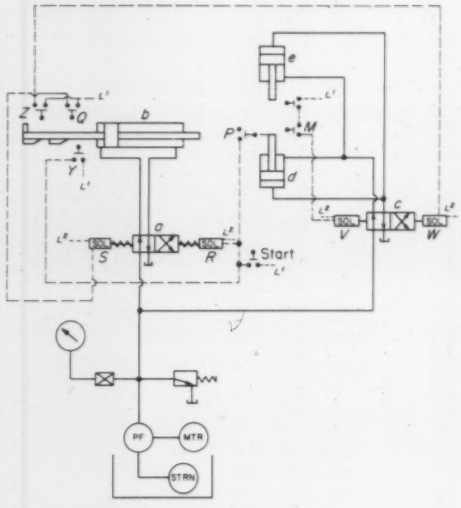
For rapid action of control elements, air-operated pilots can be employed. An advantage of this type lies in the elimination of pilot exhaust lines. Design of the pilot-operated four-way valve is quite different from that of the hydraulically operated four-way valve. In the typical pilot-valve cross-section shown in Fig. 6, it is noted that the pilot chambers resemble single-acting pneumatic cylinders.

Dual Pressure Pump Sequencing

Where there is a considerable difference in the loads on a pair of sequenced cylinders, a dual-pressure pumping arrangement can be employed. In the circuit illustrated in Fig. 7, operating-pressure requirement of the first movement in the cycle must be considerably less than that of the second movement. This particular circuit maintains the system under high pressure during the standby period. If this is objectionable, a pressure switch can be used to automatically stop the power-unit motor during standby.

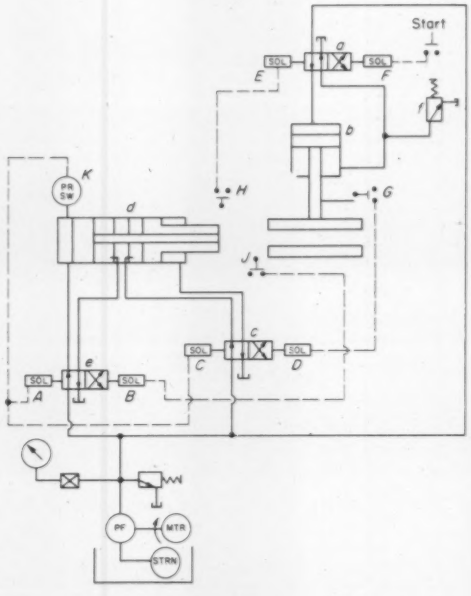
Solenoid-Valve Sequencing

Positive sequencing can be obtained by use of limit switches and solenoid-operated valves. In the circuit illustrated in Fig. 8, abnormal pressure rise caused by friction in machine ways, blockage by the work piece, or other causes will not prematurely actuate the secondary circuit. Another version of an electromechanical sequencing system is shown in Fig. 9.



1. Operator momentarily depresses start button to energize solenoid *R* of valve *a*. Spool shifts and directs oil to left end of feed-circuit cylinder *b*. Piston *b* partially advances and moves workpiece into the fixture.
2. When cam on piston rod *b* rides clear of limit switch *Y*, solenoid *R* is de-energized and piston movement stops. At same moment, limit switch *Z* is actuated, energizing solenoid *W* of valve *c*, directing oil to blind ends of work cylinders *d* and *e*.
3. Pistons *d* and *e* advance, performing operation on workpiece.
4. Limit switches *L* and *M*, which are connected in series, pass current to solenoid *V* on valve *c* when pistons *d* and *e* are fully extended. Spool of valve *c* shifts and sends oil to rod ends of work cylinders *d* and *e*, which then retract.
5. When piston *d* retracts fully, limit switch *P* energizes solenoid *R* again, directing oil to cylinder *b*, which extends fully and pushes the workpiece out of the fixture.
6. At end of unloading stroke, piston *b* actuates solenoid *S* of valve *a*, directing oil to right end of cylinder *b*, which then retracts to starting position.

Fig. 8—Positive sequencing by use of limit switches and solenoid valves. Unscheduled pressure rise caused by workpiece blockage, friction, etc., cannot prematurely actuate the secondary circuit in this system.



1. Operator momentarily depresses start button, energizing solenoid *F* of four-way valve and directing oil to blind end of clamp cylinder. Piston clamps workpiece.
2. Limit switch *G* is actuated as piece is clamped. This energizes solenoid *D* of valve *c*, which sends oil to center section of duplex cylinder *d*. Outer piston advances and flanges workpiece.
3. Piston advance actuates limit switch *J*, which energizes solenoid *B* of valve *e* directing oil to blind end of staking cylinder *d*.
4. Pressure builds up at end of staking stroke, closing pressure switch *K*. Switch energizes solenoid *A* of valve *e* and solenoid *C* of valve *c*. Valve spools shift to original positions, directing oil to rod ends of duplex cylinder *d*. Both pistons retract.
5. As duplex pistons retract, limit switch *H* is momentarily actuated, and solenoid *E* of valve *a* is energized. Oil is sent to rod end of cylinder *b*, which retracts and completes the cycle. During standby, relief valve *f* spills oil to the reservoir.

Fig. 9—Solenoid-valve sequencing circuit for clamp-flange-stake operation.

A simplified approach to optimum design of

PIN KEYS

By JACK PAULL
Electron Tube Div.
Radio Corp. of America
Harrison, N. J.

A SIMPLE but effective technique for coupling a drive shaft with other rotating members is offered by the transverse pin key, Fig. 1. This article presents a practical method for determining the optimum size of such pin elements. Applicable to problems involving either equal or unequal yield strength values, design equations and a chart provided here permit direct determination of optimum pin diameter from the shear-strength ratio of pin and shaft materials.

Symbols are defined in Nomenclature and Fig. 1.

Nomenclature

A_p	= Area of elliptical cross section of pin at intersection with shaft surface, sq in.
$B(\alpha)$	= Shaft-strength factor, Equation 4
$C(K)$	= Pin-strength factor, Equation 5
K	= r_p/r_s = Radius ratio
r_p, r_s	= Radii of pin and shaft, respectively, in.
S_p, S_s	= Shear yield strengths of pin and shaft materials, respectively, psi
α	= Design parameter for shaft-strength calculations, Fig. 1, rad
θ	= Design parameter for pin area calculations, Fig. 2, rad

Basic Relationships: From analysis of torque capacities and geometry of the pin and shaft assembly, Fig. 1, it can be shown that

$$A_p \frac{S_p}{S_s} = \frac{r_s^2}{4} (\alpha - \sin\alpha\cos\alpha) \times \left[2 + \frac{4\sin^3\alpha\cos\alpha}{3(\alpha - \sin\alpha\cos\alpha)} \right] \quad (1)$$

Area of the pin at its intersection with the shaft, Fig. 2, can be determined from

$$A_p = 4 r_s^2 \left[(K^2 - 1) \int_0^{\pi/2} \frac{d\theta}{\sqrt{1 - K^2\sin^2\theta}} + \int_0^{\pi/2} \sqrt{1 - K^2\sin^2\theta}\, d\theta \right] \quad (2)$$

where the two integral quantities are elliptic forms that can be evaluated from standard tables of elliptic integrals.

Combining Equations 1 and 2 and simplifying lead to an expression of the form,

$$B(\alpha) = \left[\frac{S_p}{S_s} \right] C(K) \quad (3)$$

where functions $B(\alpha)$ and $C(K)$ are defined by

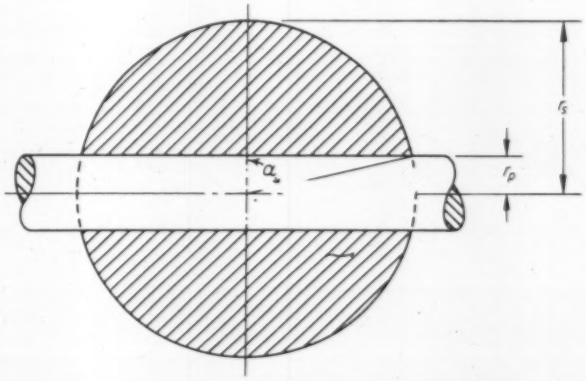


Fig. 1—Geometry of pin-key assembly showing dimensional parameters employed for calculation of optimum pin size

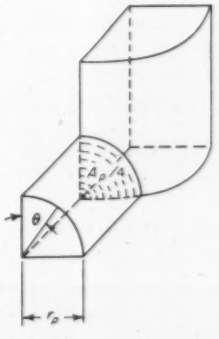


Fig. 2—Geometry of pin-key intersection with shaft surface showing dimensional parameters employed for calculation of area A_p of elliptical pin cross section

$$B(\alpha) = \frac{\alpha - \sin\alpha\cos\alpha}{4} \times \left[2 + \frac{4\sin^3\alpha\cos\alpha}{3(\alpha - \sin\alpha\cos\alpha)} \right] \quad (4)$$

$$C(K) = 4\left[(K^2 - 1)\int_0^{\pi/2} \frac{d\theta}{\sqrt{1 - K^2\sin^2\theta}} + \int_0^{\pi/2} \sqrt{1 - K^2\sin^2\theta}\, d\theta \right] \quad (5)$$

Chart Solution: To permit quick determination of K, parameters B (α) and (S_p/S_s) C (K) have been plotted against values of K in Fig. 3. The plot of B (α) is a dimensionless index of shaft strength. The curves for (S_p/S_s) C (K) provide an indication of pin strength, and are plotted for uniform increments of shear-strength ratio of pin and shaft materials.

Fig. 3 shows that where pin and shaft are made of the same material, ratio $S_p/S_s = 1$, the optimum value of $K = 0.395$. It also shows, as might be expected, that the value of K varies inversely with S_p/S_s.

Curves for intermediate values of (S_p/S_s) C (K) may be interpolated, as shown by the dashed curve for $S_p/S_s = 0.95$. For this curve plot the optimum value of K is 0.4; that is, a 1-in. diameter shaft would require a 0.4-in. diameter pin.

In the case of a taper pin, radius r_p as determined by this method is that at the center of the shaft.

Validity of Results: Accuracy of the method was demonstrated in a series of torsion tests conducted at the Polytechnic Institute of Brooklyn. Shear-strength ratios of pin and shaft materials ranged from 0.4 to 1.3. In a test of a 1/4-in. diameter shaft with a 4/0 taper pin (average diameter, 0.0986 in.), both of SAE 1112 steel, the pin and shaft failed simultaneously. Calculated value of K for this pin-shaft combination is 0.3944. The value as determined by the intersection of the curve for (S_p/S_s) C (K) with the plot of factor B (α) in Fig. 3 is $K = 0.395$.

In additional torsion tests of assemblies using shafts and taper pins of the same material, it was found that the torque required to cause failure of the assembly increased with the ratio of pin radius to shaft radius until a ratio of approximately 0.4 was reached. Above this ratio the failure torque decreased. With the method of analysis described here, selection of pin size can be readily varied to accurately control the point of pin failure, as may be required in shear-pin applications.

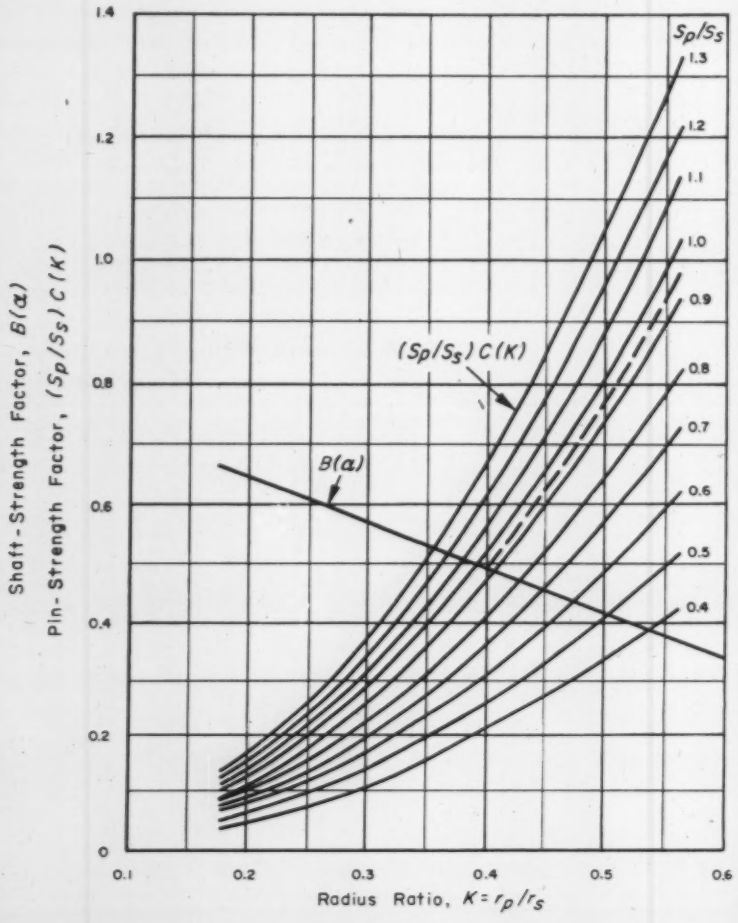
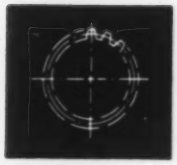
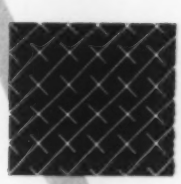
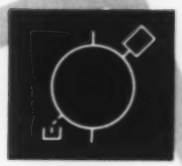


Fig. 3—Chart for determination of optimum ratio of pin-key radius to shaft radius. Curves for pin-strength factor (S_p/S_s) C (K) represent different values of the ratio of shear yield strengths for pin and shaft materials. Intersection of these curves with the plot for shaft strength factor B (α) locates the optimum design point (simultaneous failure of pin and shaft). Dashed curve illustrates method of interpolating plotted values $(S_p/S_s = 0.95)$



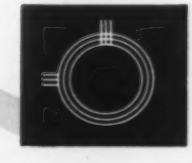
DESIGN ENGINEERING SHOW GUIDE





Third Design Engineering Show and Conference

Chicago International Amphitheatre, April 14-17, 1958



Ideas into products . . .

1958 DESIGN

IDEAS + components + materials + methods — these form new products. And supplying the plus signs necessary for this combination is the design engineer's function.

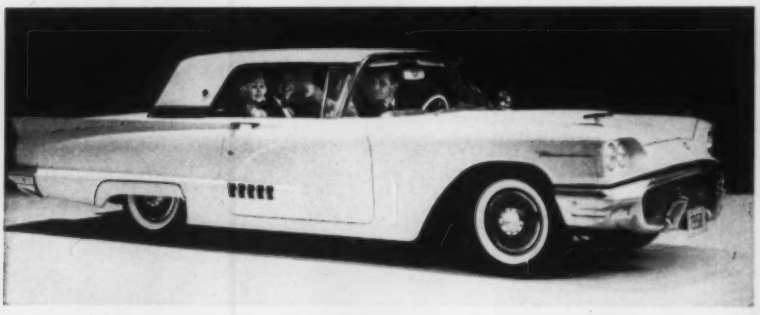
The untiring appliances, brilliant computers, nimble automatic production machinery, and other such commonplace wonders of today's engineering eventually will be improved or replaced by something that can do the job better or more economically. Improvement, replacement—both mean new ideas, new components, new materials, new methods, to the design engineer.

Part of the design engineer's job is to obtain information on developments that may be of direct use or of basic interest in his work. His responsibility to keep up with latest developments grows with the increasing complexity of products.

A new source of information—the Design Engineering Show and Conference—was first offered the engineer three years ago. With a comparatively modest start in 1956, the Design Show has grown in size and stature to one of the largest and, to the design engineer, one of the most important annual industrial expositions in the country.

The 1958 Design Engineering Show presents a display of thousands of new developments—in the form of ideas and discussion at the conference sessions, as well as in the form of actual things to see, touch, and watch work.

MACHINE DESIGN, in this Design Show Guide, presents an outline of the conference program, a pictorial representation of recent developments on display, a floor plan of the Chicago Amphitheatre exhibit area, and a listing of the more than 400 exhibitors.



ENGINEERING SHOW

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- Fluid Power Components 164
- Mechanical Parts 168
- Materials 176
- Engineering Equipment 179

Conference Program 180
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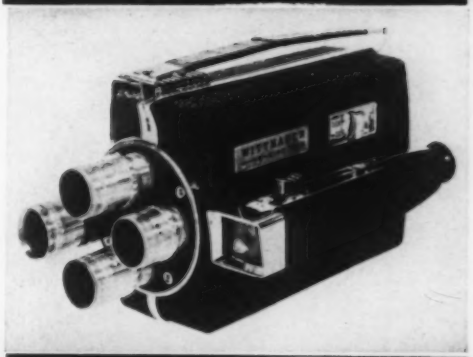
Floor Plan of the Amphitheatre 184

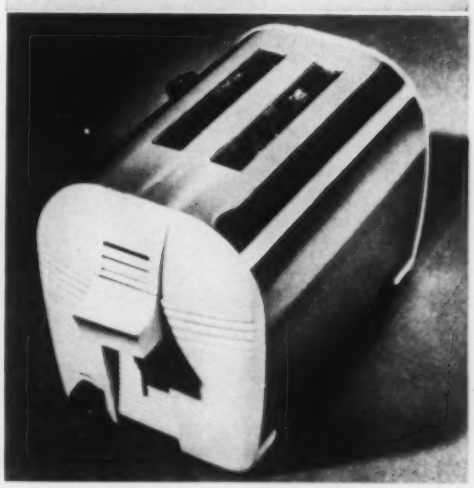


The Show

Place: International Amphitheatre, Chicago
Dates: April 14 through 17, 1958
Hours: Noon to 5:30 p.m. daily
Fee: A registration fee of $2 is payable only at the registration desk at the Show.

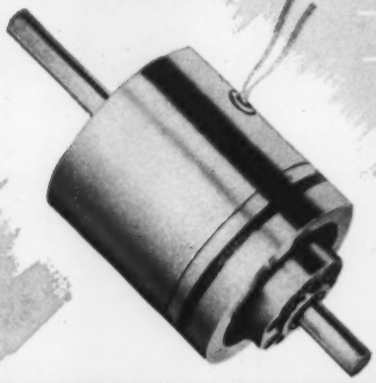
The Conference

Place: International Amphitheatre, Chicago
Dates: April 14 through 17, 1958
Hours: Monday, April 14 . . . 10:00 a.m. to noon
Tuesday, April 15 . . . 9:30 a.m. to noon
Wednesday, April 16 . . . 9:30 a.m. to noon
Thursday, April 17 . . . 9:30 a.m. to noon
Sponsor: Machine Design Div., American Society of Mechanical Engineers
Fee: ASME members, $5; nonmembers, $10. This charge includes a copy of the Conference Proceedings and admission to the Show.

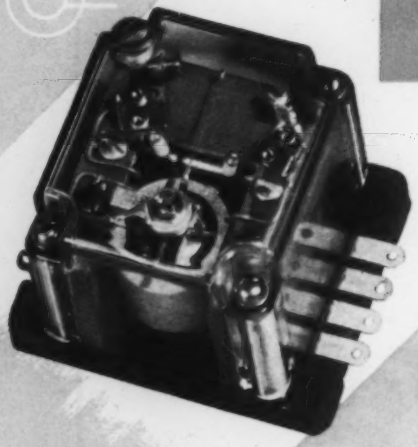


1. Pushbutton Switch

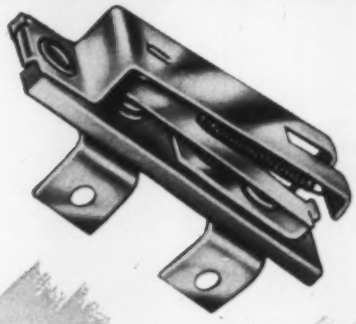
2. Fixed-Field Clutches



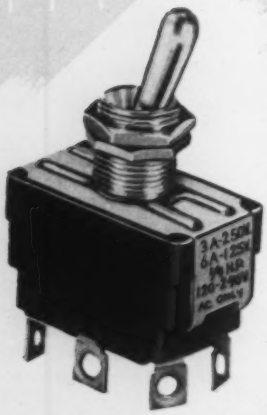
Ideas on Display at the Design Engineering Show



4. Magnetic Contact Relay



5. Subminiature Switch

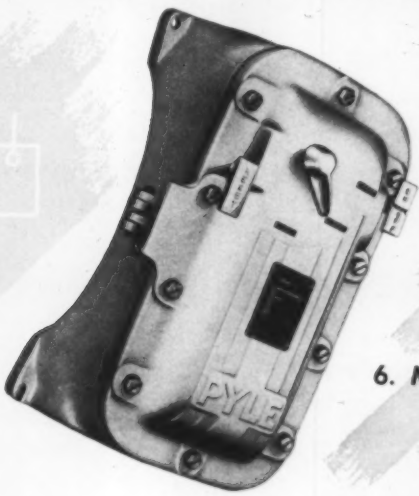


7. Light-Duty Switch

8. Instant-Reverse Mechanism

3. Indicating Light

ELECTRICAL PARTS



6. Motor Starter

9. Terminal

1. **For modular mounting** on control panels, lighted pushbutton switch combines nameplate, pilot light and switching unit. Wide range of operating and indicating conditions can be achieved and identified. *Electro-Snap Switch & Mfg. Co.—Booth* 228.

Circle 681 on Yellow Card

2. **Diaphragm is only moving part** in fixed-field electric clutch available in three styles: Coupling, clutch, and coupling-brake. Six miniature and small sizes range from $\frac{7}{8}$ to $3\frac{1}{8}$ in. diam. Torque output ranges from 10 oz-in. to 100 lb-in. *Simplatrol Products Corp.—Booth* 539.

Circle 682 on Yellow Card

3. **Checking indicating lights** without disturbing the control circuit and without removing a lens or bulb is possible with Pres-Test indicating light. Depth of pushbutton behind panel is 1 23/32 in. for transformer types and $1\frac{7}{8}$ in. for resistor units. Seals assure oil-tightness. *Cutler-Hammer Inc.—Booths* 681, 683.

Circle 683 on Yellow Card

4. **More than 500 g force** will not damage model 281 10-ma magnetic contact relay. It will also withstand vibration of 5 to 55 cycles per second at 0.06-in. amplitude. Relay is small—2 x $1\frac{3}{4}$ x $1\frac{1}{2}$ in.—and has self-contained reset mechanism. *Assembly Products Inc.—Booth* 1039.

Circle 684 on Yellow Card

5. **Flexibility in mounting and connection** is feature of S70-00A series snap-action switch. Rating is 6 amp, 125 v ac, single-pole normally open; size, 1 x 9/32 x $\frac{1}{4}$-in. *Cherry Electrical Products Corp.—Booth* 309.

Circle 685 on Yellow Card

6. **Explosionproof, dust-tight** and weather-resistant magnetic across-the-line motor starter Pylet is available for $1\frac{1}{2}$ to 100 hp. Housing design permits installation of maximum number of starters in a given area. *Pyle-National Co.—Booth* 1073.

Circle 686 on Yellow Card

7. **Slow-make, slow-break switch,** designed primarily for use on alternating current, has silver contacts and features one-hole mounting. Single and double-pole models are rated 3 amp, 250 v and 6 amp, 125 v. *—Circle F Mfg. Co.—Booth* 460.

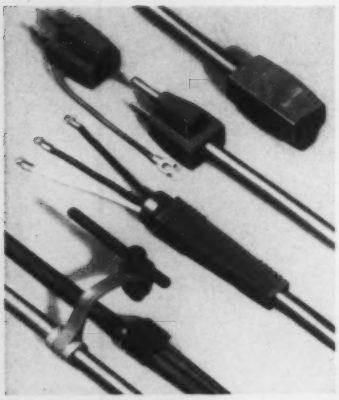
Circle 687 on Yellow Card

8. **Independent of relay action** and not requiring delay of mechanical contact with the centrifugal switch, Inst-O-Verse is available with single-phase, 1725-rpm, 115 or 230-v, sleeve or ball-bearing motors in 1/16 to 1-hp ratings. Reversing switch is automatically preset by shaft rotation. *Franklin Electric Co. Inc.—Booth* 484, 486.

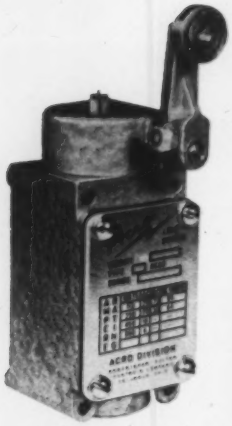
Circle 688 on Yellow Card

9. **Four-way pressure crimp** terminal can be used on stranded or solid wire. Three sizes are available for wire sizes No. 22-16, 16-14 and 12-10. *Buchanan Electrical Products Corp.—Booth* 1057.

Circle 689 on Yellow Card

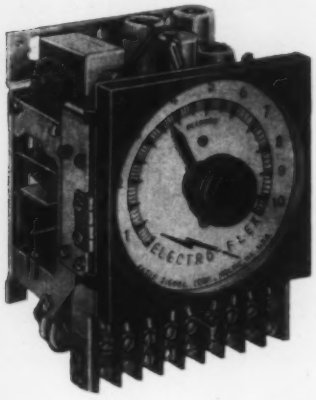


1. Cordsets



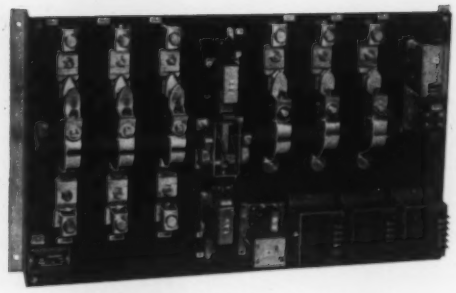
2. Limit Switch

3. Short-Interval Timer



6. Heating Element

9. Miniature Thermostat



10. Automatic Transfer Switch

1. Three-wire cordsets and cord accessories are designed for appliances and power tools which must be electrically grounded. Plugs and connectors are molded of vinyl plastic in a wide range of colors. *Miller Electric Co.—Booth* 1071.

Circle 690 on Yellow Card

2. Designed for machine tools, precision limit switch can control as many as four separate circuits for pilot or line duty. Actuation is adjustable in full 360-deg sweep, on two different planes. *Acro Div., Robertshaw-Fulton Controls Co.—Booth* 1064.

Circle 691 on Yellow Card

3. Only moving parts are armatures of two relays in the Electroflex electronic reset timer, for intervals from 0.05 to 10 seconds. Accuracy is maintained within 2 per cent of initial setting. *Eagle Signal Corp.—Booth* 301.

Circle 692 on Yellow Card

4. Switching loads to 30 amp at 30 v dc are possible with a modified version of the KG relay for applications where 100 g shock and vibrations of 30 g to 2000 cps are required. Double-pole double-throw relay operates on 2-w, 12-millisecond pulses. *Potter & Brumfield Inc.—Booth* 531.

Circle 693 on Yellow Card

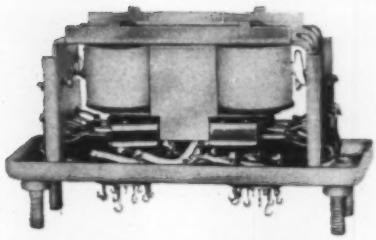
5. Uncovered model A-1 thermostat has short sensing element. It controls temperatures within $\pm\frac{1}{2}$ F in liquids and ± 1 F in air, operating in the range of 35 to 600 F. *Burling Instrument Co.—Booth* 203.

Circle 694 on Yellow Card

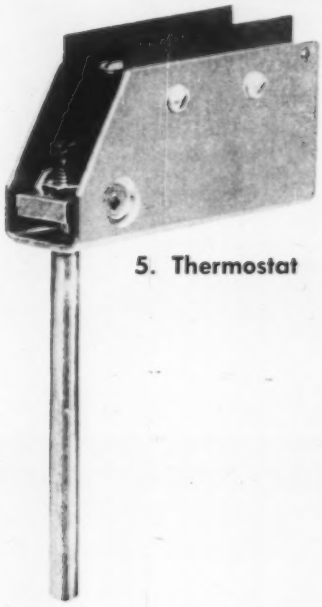
6. Flexibility of insulated heating element permits use in areas which are not flat. Silicone-rubber cover is flexible from -90 to 450 F. *Electro-Flex Heat Inc.—Booth* 571.

Circle 695 on Yellow Card

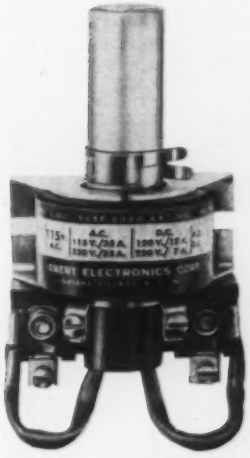
7. Small, 75-amp capacity Little Giant mercury-to-mercury relay measures



4. Magnetic Latching Relay



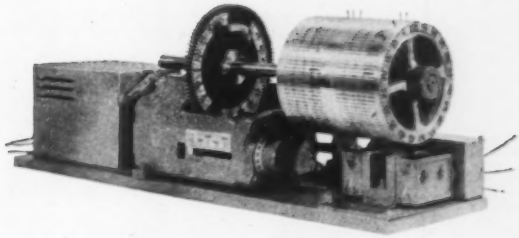
5. Thermostat



8. Encapsulated-Coil Relay

7. Mercury Relay

11. Solderless Connector



12. Repeat Cycle Timer

4 23/32 x 2 3/16 x 2 1/16 in. over-all. Relay is rated at 8000 w tungsten, based on 115 v, 50-60 cycles. *Adams & Westlake Co.—Booth* 556.

Circle 696 on Yellow Card

8. **Protection from harmful atmospheric conditions** is provided by encapsulation in polyester resin compound. Relay has hermetically sealed mercury-to-mercury contacts. Encapsulated coils are also available for other relays. *Ebert Electronics Corp.—Booth* 325.

Circle 697 on Yellow Card

9. **Inherent sensitivity of less than 1 F** is characteristic of 1.25 x 0.562 x 0.401-in. Thermoswitch. Operating temperature limits are −65 to 220 F; switch is adjustable over −20 to 200 F range. It resists 10 g acceleration at 500 cps vibration. *Fenwal Inc.—Booth* 100.

Circle 698 on Yellow Card

10. **Voltage-sensitive relays** now available on mechanically held automatic transfer switches provide a wide range of operating adjustments. Switches are for lighting and power circuits requiring automatic transfer from normal to emergency voltage source. *Zenith Electric Co.—Booth* 469.

Circle 699 on Yellow Card

11. **Crimped pins and sockets** of AN type Hyfen connector snap into plug or receptacle and lock in place. *Burndy Corp., Omaton Div.—Booth* 450.

Circle 700 on Yellow Card

12. **Counter becomes timer** with the addition of a synchronous motor drive. Programonitor without motor drive is a recycling, circuit-controlling counter which responds to mechanical or electrical inputs. Adding constant-speed drive permits programming and recycling of complex switching patterns with respect to a time base. Maximum time cycle is 66 2/3 min. *Counter and Control Corp.—Booth* 581.

Circle 701 on Yellow Card

1. **Short, compact, lightweight** series C appliance motor operates in any position. Other features are excellent ventilation and smooth, quiet operation. *Delco Products Div., General Motors Corp.—Booth* 755.

Circle 702 on Yellow Card

2. **Electrical remote control** and speed indicator for Variator drive provides infinitely variable output speed regulation from one-third to three times input speed, or 9:1 total range. It operates clockwise or counterclockwise on input speeds to 1800 rpm. *Cleveland Worm & Gear Co.—Booth* 121.

Circle 703 on Yellow Card

3. **Reversing at any time** with motor running or not running is possible with model M14R motorized reverse speed reducer. Speed range is zero to 400 rpm to zero; torque rating is 10 lb-in. *Revco Inc.—Booth* 1067.

Circle 704 on Yellow Card

4. **Hollow shaft** of vertical shaft-mounted gearmotor supports driveshafts without using additional bearings or pillow blocks at the drive end. Gearmotor is to be flange-mounted. Capacity ranges from ¼ to 25 hp. Twenty-seven output speeds range from 525 down to 7.3 rpm, with 1750-rpm input. *Michigan Tool Co., Cone-Drive Gears Div.—Booth* 823.

Circle 705 on Yellow Card

5. **Panel-mounted** remote mechanical control for Graham variable-speed drive is capable of speed setting to one part in 4000. *Graham Transmissions Inc.—Booth* 449.

Circle 706 on Yellow Card

6. **Need for complex switchgear is eliminated** in four-pole, 220-v, 1800-rpm motor. Ratings are 20 hp and higher. *Brook Motor Corp.—Booth* 217.

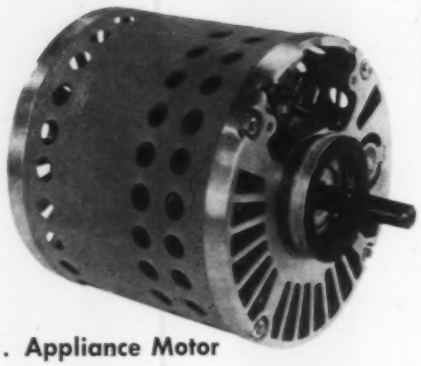
Circle 707 on Yellow Card

7. **Mounted separate,** standard NEMA motor plus gear unit meet JIC requirements for such operations. Designated Motomount Syncrogear, it is available with double-reduction gears in ratios ranging from 7.1:1 to 47:1. Speed ranges are 37 to 280 rpm; horsepower ratings, from 1 to 30 hp. *U. S. Electrical Motors Inc.—Booth* 212.

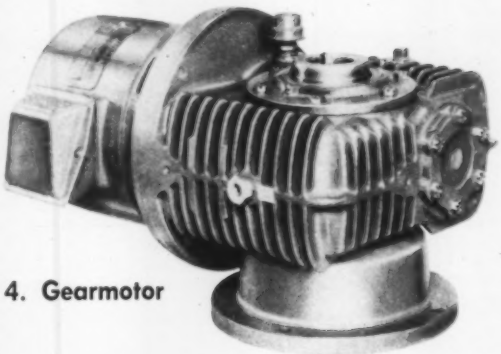
Circle 708 on Yellow Card

8. **Uniform brush pressure** for the life of the brushes is provided by a Neg'ator spring in 1¼-in. diam permanent-magnet dc motor designed to meet MIL-M-8609 specifications. Operating temperature range is −65 to 300 F. *Barber-Colman Co.—Booth* 687.

Circle 709 on Yellow Card



1. Appliance Motor



4. Gearmotor

6. Increment-Start Motor

9. Lightweight Motor

9. **Under 4 in. in length,** shaded-pole motor weighs 5.5 lb. Ventilation openings are in both the shell and end shields. Motor is available in ratings from 0.035 to 0.1-hp in four and six-pole sizes for operation at one, two or three speeds. *General Electric Co.—Booths* 872, 874.

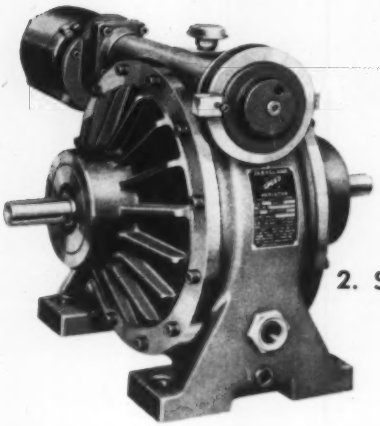
Circle 710 on Yellow Card

10. **Operation of direct-current gearmotors** from alternating current permits control of the motor through a wide range of speeds. Janette variable speed control uses a variable voltage ac transformer and dry disc type rectifiers. *Janette Electric Mfg. Co.—Booth* 871.

Circle 711 on Yellow Card

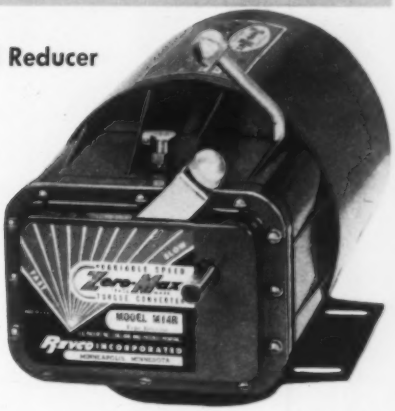
11. **Reduction of 60 per cent in length** of pancake motor over standard motors of equal rating is effected by formed end coils and one-piece housing-bearing bracket. Flange-type, radial air gap motor is available for vertical or horizontal mounting, in ratings from 1 to 15 hp at 1800, 1200 and 900 rpm. *Louis Allis Co.—Booth* 921.

Circle 712 on Yellow Card

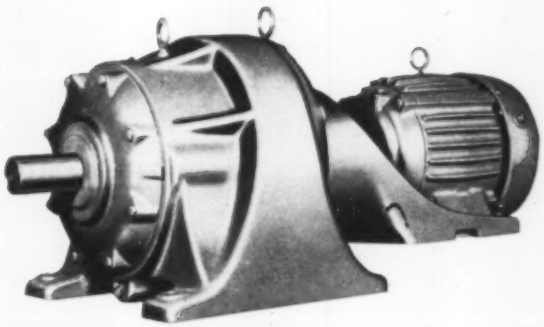


2. Speed Regulator

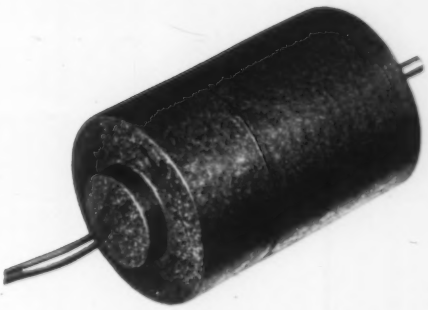
3. Speed Reducer



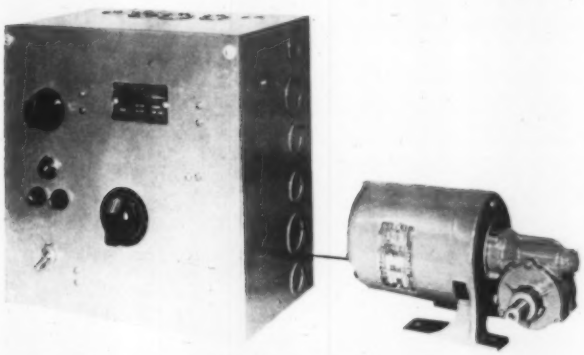
5. Remote Control



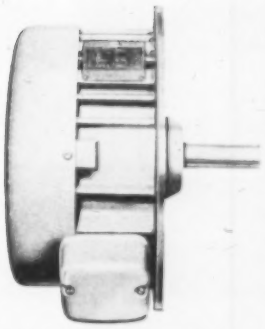
7. Packaged Power Unit



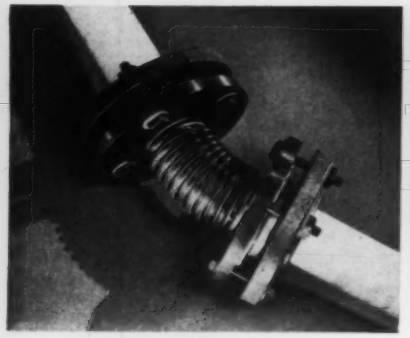
8. Permanent-Magnet Motor



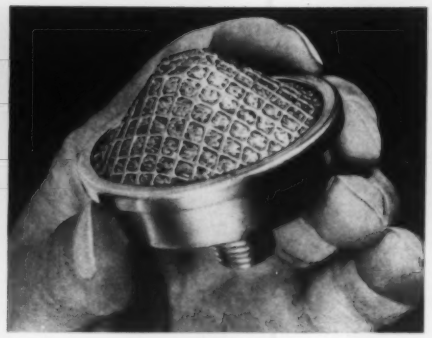
10. Variable Speed Control



11. Pancake Motor



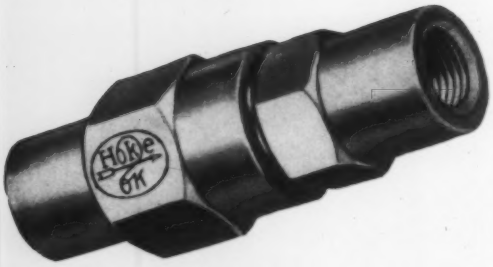
1. Teflon Bellows



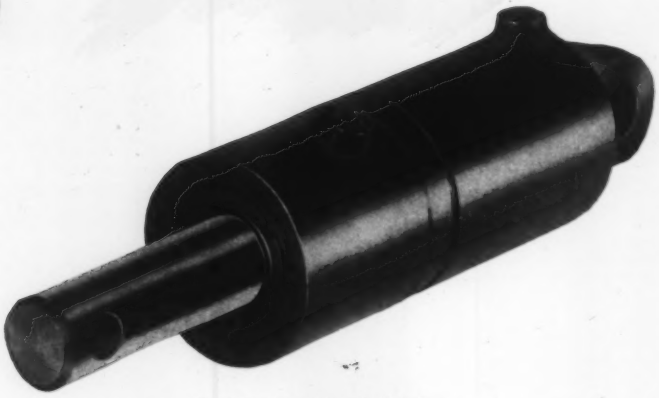
2. Silencer

3. Solenoid Valve

Ideas on Display at the Design Engineering Show

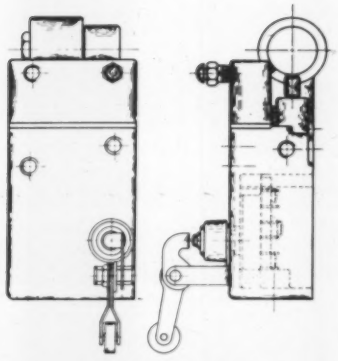


7. Check Valve

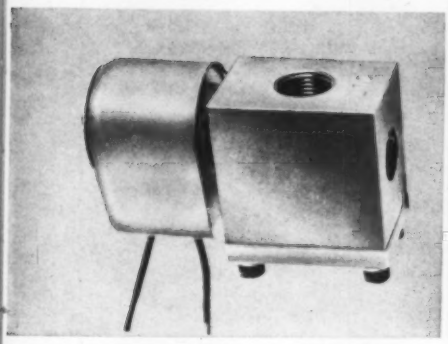


8. Hydraulic Cylinder

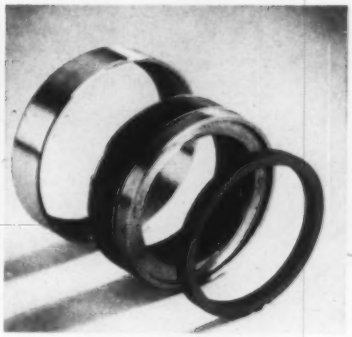
9. Solenoid Valve



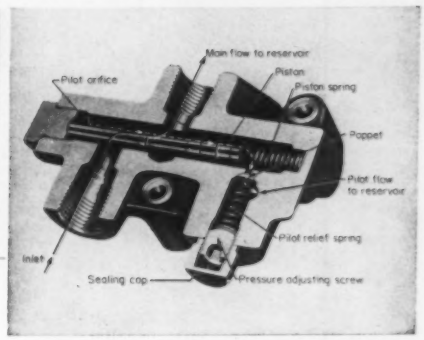
10. Air Valve



4. Solenoid Valve



5. Bellows Seal



6. Pilot-Operated Relief Valve

FLUID-POWER COMPONENTS

11. Plastic Valve

1. Molded, rather than machined, of high-density virgin Teflon compound, Fluoroflex-T bellows are usable at pressures to 120 psi and temperatures to 450 F. Full vacuum service, bending deflection up to 70 deg and axial movement to 2 in. or greater are possible. *Resistoflex Corp.—Booth* 858.

Circle 713 on Yellow Card

2. By breaking up shock waves when exhausting compressed air to the atmosphere, Muffl-Maze silencer minimizes noise level of pneumatic equipment. It is made for ⅛, ¼, ⅜, ½ and ¾ in. pipe sizes. *Air-Maze Corp.—Booth* 846.

Circle 714 on Yellow Card

3. Designed for limited-space application, small model 291 valve can be mounted in any position. For air or a variety of fluids, valve is available in brass or stainless steel in ⅛ or ¼ in. NPT sizes. *Controls Co. of America—Booths* 686, 688.

Circle 715 on Yellow Card

4. Tight shut-off on high pressures—to 1500 psi—is afforded by Bulletin 8223 valve. It can be mounted in any position and is available in ½ or ¾ in. pipe connections with general-purpose, watertight or explosionproof solenoid enclosures. *Automatic Switch Co.—Booths* 481, 483, 485.

Circle 716 on Yellow Card

5. Usable at temperatures of 700 F and higher, metal bellows seal operates at speeds to 15,000 fpm. *Sealol Corp.—Booth* 1042.

Circle 717 on Yellow Card

6. Instant reaction, clog-free operation, and silence are features of valve especially suited to hydraulic lift applications. Valve is adjustable from 500 to 2000 psi and has maximum capacity of 20 gpm. *Webster Electric Co.—Booth* 586.

Circle 718 on Yellow Card

7. Piston-type valve is one of 570 series check valves, which range in size from ⅛ to ½ in. pipe thread as well as ¼ in. Swagelok and 37-deg JIC type flare tubing connectors. Valve is available in brass or type 303 stainless steel, with maximum operating pressure of 3000 psi or 5000 psi, respectively. *Hoke Inc.—Booth* 321.

Circle 719 on Yellow Card

8. Double-acting, 3000-psi cylinder is available in sizes of 1½ through 6 in. bore in ¼ in. increments. *Benton Harbor Engineering Works Inc.—Booth* 561.

Circle 720 on Yellow Card

9. Large orifice capacity is combined with high pressure differential in a two-way solenoid valve. Normally open or normally closed R series has ¼-in. orifice and ¼-in. NPT. Pressure rating is 5 to 200 psi. *Skinner Electric Valve Div.—Booth* 940.

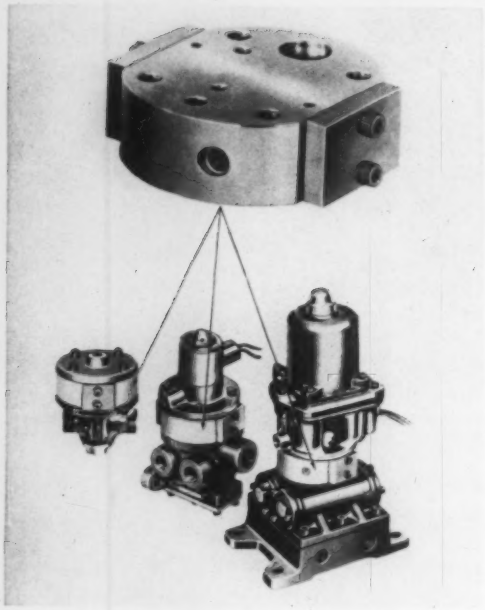
Circle 721 on Yellow Card

10. Four-way slide valve can be used to obtain reciprocating action of double-acting cylinders with either long or short stroke. Size of Control-Pac is 3 x 2 x 6⅞ in., including solenoid pilot valve. Ports in valve plate are ¼ in. diam. *Dixon Automatic Tool Inc.—Booth* 634.

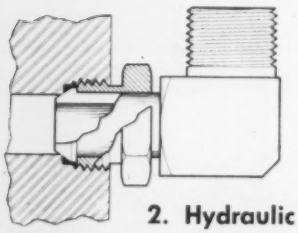
Circle 722 on Yellow Card

11. Long-life SV-5100 series solenoid valve is made of molded nylon with a plastic diaphragm seal for bubble-tight sealing. The 115-v ac, 60-cycle valve features a maximum current drain of 10 w. *Valcor Engineering Corp.—Booth* 567.

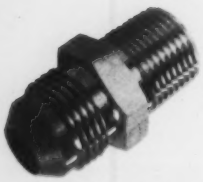
Circle 723 on Yellow Card



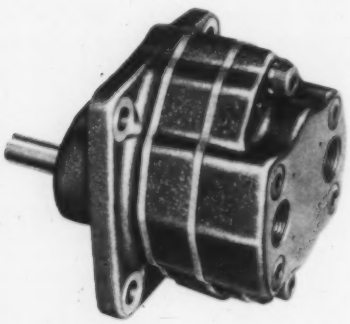
1. Double-Stroke Adaptor



2. Hydraulic Fitting

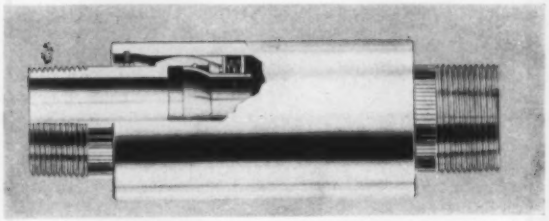


3. Tube Fitting



4. Hydraulic Pump

5. Pump and Motor



6. Expansion Joint

1. Inserted between valve head and body, air-index adaptor converts Ross Skyline series valve to momentary action. *Ross Operating Valve Co.—Booth* 825.

Circle 724 on Yellow Card

2. Leakproof seal is provided by metal-to-metal contact between seat and a machined step in the fitting body. Self-flaring, no-flare, and flare type straight-thread fittings are available in ¼ to 2-in. OD sizes. *Flodar Corp.—Booth* 1029.

Circle 725 on Yellow Card

3. Specially treated flare nose on Triple-lok tube fitting provides a connection that will hold even helium. It withstands severe stresses and strains, high temperatures and pressures. *Parker-Hannifin Corp., Parker Fittings & Hose Div.—Booth* 118.

Circle 726 on Yellow Card

4. Only two moving parts are incorporated in Powermax series of external gear type rotary hydraulic pumps and fluid motors. Seven models have capacities from 1.2 to 14.2 gpm, for pressures to 1500 psi and speeds to 3600 rpm. *Tuthill Pump Co.—Booth* 465.

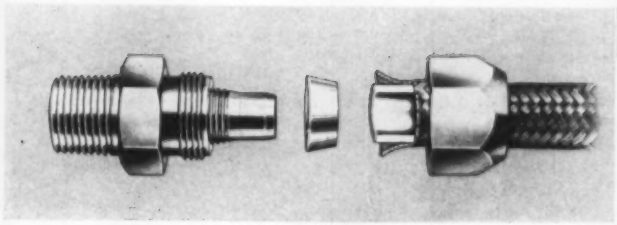
Circle 727 on Yellow Card

5. Maximum capacity ranges from 0.6 to 6.7 gpm in compact T series pump unit. Maximum operating pressure is 400 psi. Ports are ½ in. NPT. *Roper Hydraulics Inc.—Booth* 423.

Circle 728 on Yellow Card

6. Possibility of blowouts is eliminated by absence of stainless steel bellows in expansion joint for ½ to 6-in. pipe sizes. Maximum operating pressure is 500 psi; temperature limit is 500 F. *Rotherm Engineering Co. Inc.—Booth* 1023.

Circle 729 on Yellow Card



7. Reusable Fitting

7. **Three pieces** comprise Springfield 140 fitting: Compression nut, tapered ring, and nipple insert. Only the stainless-steel insert is in contact with fluid. Sizes range from ¼ to ¾ in. and include JIC and SAE fittings. *Titeflex Inc.—Booth* 938.

Circle 730 on Yellow Card

8. **Compact, lightweight** 7-hp rotary air motor is only 7⅝ in. high and weighs 65 lb. At 300 rpm and over, speed is infinitely variable with air-valve control. Model 16AM operates at pressures from 30 to 90 psi. Rating at 90 psi is 5.8 hp at 1500 rpm, 7 hp at 2000 rpm. *Gast Mfg. Corp.—Booth* 1013.

Circle 731 on Yellow Card

9. **Pressures of 1200 psi** and temperatures to 1350 F are accommodated by seals for aircraft, missile and other industries. Sizes are ¼ to 13 in. diam for shafts running at speeds to 80,000 rpm, with rubbing velocities over 400 fps. *Cleveland Graphite Bronze Co. Div., Clevite Corp.—Booth* 910.

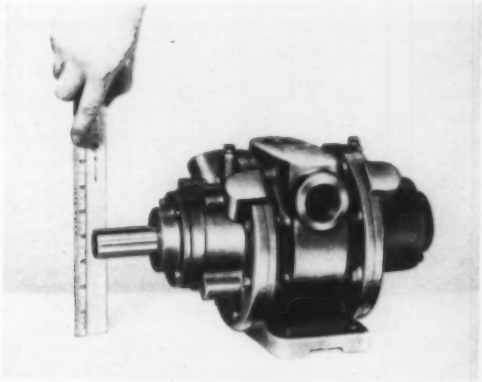
Circle 732 on Yellow Card

10. **Available in brass** as well as steel and stainless steel, Hi-Seal fitting is made for ⅛ to 1½ in. OD tubing. Tubing bottoms on shoulder of fitting; threads on body of fitting are completely covered by the nut when joint is properly assembled. *Imperial Brass Mfg. Co.—Booth* 471.

Circle 733 on Yellow Card

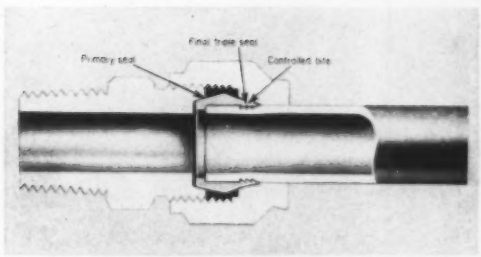
11. **Low starting and running torque** of type C joint keeps power requirement low. Pressure limit with steam is 200 psi; with hydraulic fluid, 400 psi. Eight standard sizes range from ½ to 3 in. *Barco Mfg. Co.—Booth* 583.

Circle 734 on Yellow Card

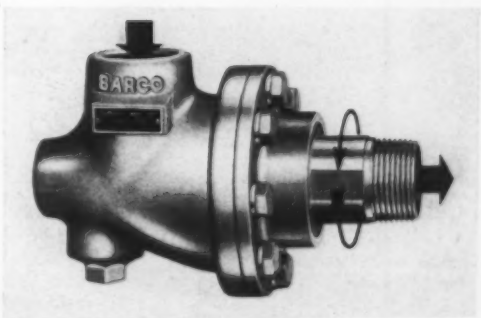


8. Air Motor

9. Mechanical Seals



10. Butt Joint Fitting



11. Rotary Joint

1. **Solid inner and outer raceways** and a full ball complement without loading slot or split races are features of Unibal bearing. Deep, unbroken ball grooves provide durability and maximum capacity for radial and thrust loads. *Nice Ball Bearing Co.—Booth* 131.

Circle 735 on Yellow Card

2. **Minimum magnetic retention** is present in clutches and brakes for automatic machinery, machine tools, and instruments. Torque ratings range from 36 to 48,000 lb-in.; sizes, from 2 to 13 in. *Fawick Airflex Div., Fawick Corp.—Booth* 658.

Circle 736 on Yellow Card

3. **High speed, quiet operation, and long life** under adverse operating conditions such as misalignment, shaft deflection, and movement of irregular masses, are features of Crown-Ground spur and helical gears. *Sier-Bath Gear & Pump Co. Inc.—Booth* 677.

Circle 737 on Yellow Card

4. **Antibacklash gears,** both Precision Class I and Class II, are available in six diametral pitches, $\frac{5}{8}$ to 1 in. OD. Solid pin type and clamp type hubs and three different bore sizes are available. *Dynamic Gear Co. Inc.—Booth* 451.

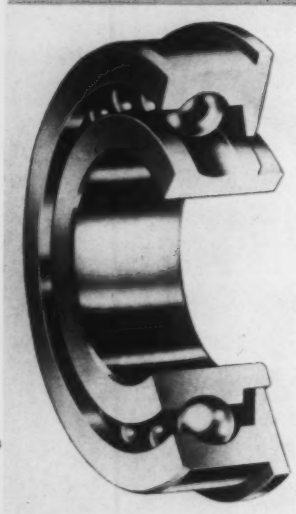
Circle 738 on Yellow Card

5. **Unbreakable malleable housing** is feature of pillow blocks for two shaft heights, in 28 sizes for $\frac{1}{2}$ to 2 7/16 in. shafts. Self-aligning ball bearing units are permanently lubricated and sealed. *Browning Mfg. Co.—Booth* 491.

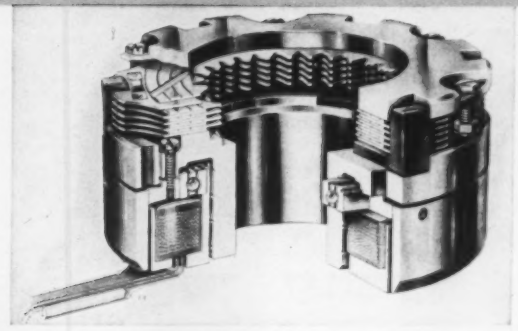
Circle 739 on Yellow Card

6. **Sleeve-bearing,** large-bore Series FSS backstop clutches have maximum

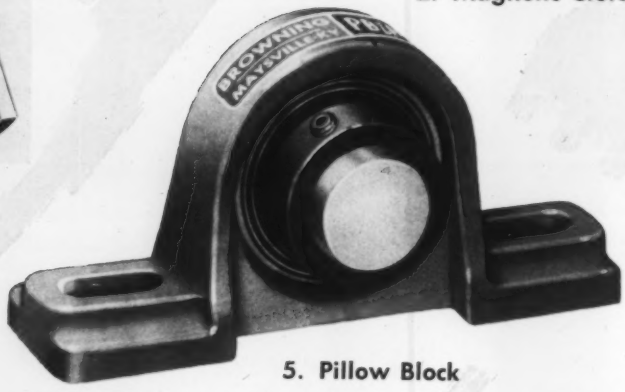
Ideas on Display at the Design Engineering Show



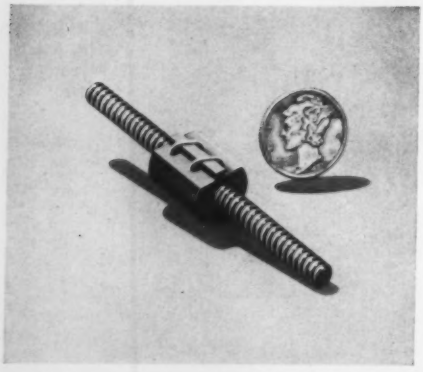
1. Ball Bearing



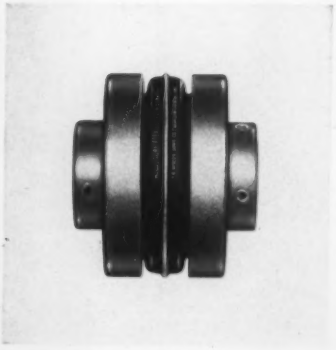
2. Magnetic Clutches and Brakes



5. Pillow Block



7. Ball Bearing Screw



8. Flexible Coupling

bore diameters of 6, 7, 8, 9, 10, and 12 in. They offer economy of sleeve bearings where application does not require higher speed characteristics of ball-bearing backstops. *Formsprag Co.—Booth* 643.

Circle 740 on Yellow Card

7. **Efficiency of 90 per cent** or higher is provided by miniature lightweight ball bearing screw with 3/16 in. ball circle diameter. It operates at near maximum efficiency at temperatures as low as −65 F and will position components to within 0.0005-in. for each inch of travel. *Saginaw Steering Gear Div., General Motors Corp.—Booth* 434.

Circle 741 on Yellow Card

8. **Torsional flexibility is 15 deg** at peak torque in Sure-Flex flexible coupling. Split rubber sleeve prevents transmission of shock and vibration to the driven unit and eliminates metal-to-metal contact between shaft ends. Six sizes are available for motors up to 200 hp at 1750 rpm; shaft bores are ⅝ to 2¼ in. *T. B. Wood's Sons Co.—Booth* 938-A.

Circle 742 on Yellow Card

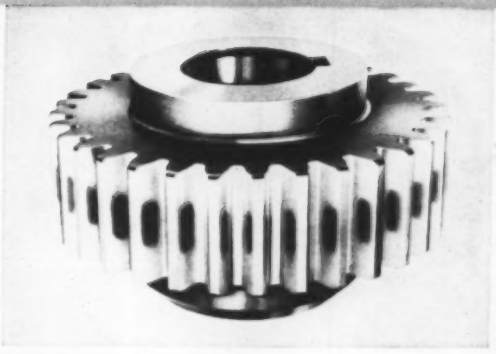
9. **Porous powdered metal** is used to fabricate self-aligning bearing. Outer member holds approximately 20 per cent of its own volume in oil; weekly oiling is usually sufficient. *Heim Co.—Booth* 834.

Circle 743 on Yellow Card

10. **Precision units** for standard BuOrd servomotor sizes 11 and 15 are available with ratios up to 3500:1, with torque rating of 25 oz-in., and maximum backlash of 10 min. Over-all length is 0.8 in. *U. S. Gear Corp.—Booth* 315.

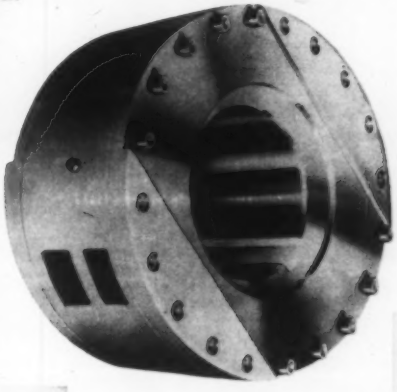
Circle 744 on Yellow Card

MECHANICAL PARTS



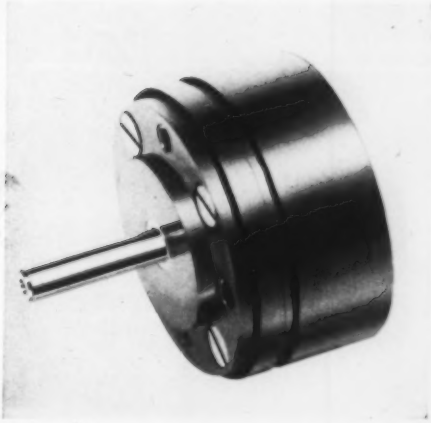
3. Case-Hardened Gear

4. Miniature Gears

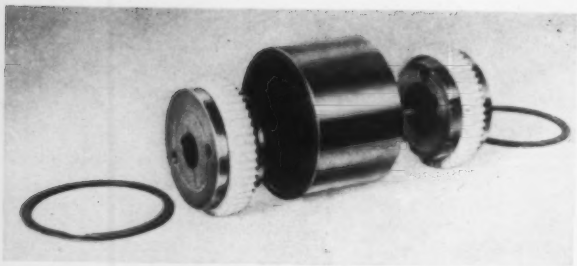


6. Backstop Clutch

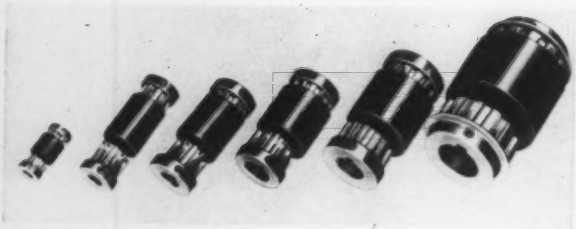
9. Spherical Bearing



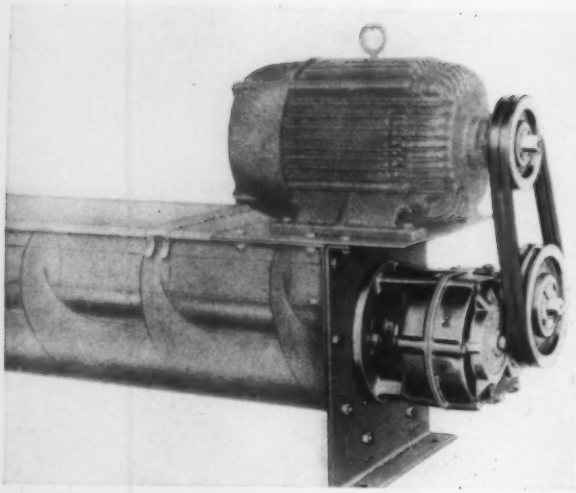
10. Planetary Gearhead



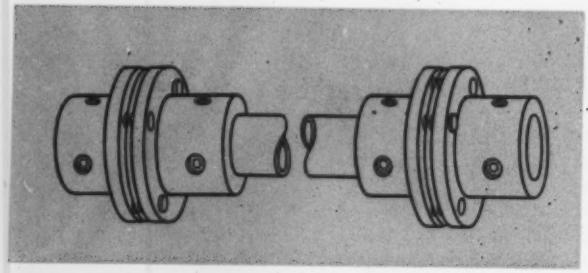
1. Gear Coupling



2. Flexible Couplings



3. Screw Conveyor Drive



4. Miniature Coupling

1. **Nylon gear teeth** mesh into steel sleeve in 162M coupling; no lubrication is required. Interchangeable Taperlock bushings fit shaft sizes ½ to 1⅝ in. *John Waldron Corp.—Booth* 457.

Circle 745 on Yellow Card

2. **Torsional resilience** with angles of twist up to 30 deg is provided for subfractional, fractional, and integral-horsepower motor applications by Gear-Grip couplings. Six basic hub sizes meet requirements for ½ to 30-hp motors. *Guardian Products Corp., Coupling Div.—Booth* 448.

Circle 746 on Yellow Card

3. **Simple to mount and adjust** on standard conveyor troughs, screw conveyor drive consists of a speed reducer with packing gland and drive shaft, which mounts on trough end. Four sizes are available, each in 18:1 and 8:1 ratios. *Dodge Mfg. Corp.—Booths* 1077, 1079.

Circle 747 on Yellow Card

4. **Floating and semifloating** type 50-CE shaft couplings are made in miniature sizes. Floating shaft is held concentric by disc rings at both ends. Semifloating shaft has a single-flexing coupling on one end only, the other end being supported by an outboard bearing. *Thomas Flexible Coupling Co.—Booth* 1018.

Circle 748 on Yellow Card

5. **Any helical-gear drive configuration** can be assembled from Moduline speed-reducing apparatus. Heart of the line is a double-reduction cage with a fixed 5:1 set of low-speed gears. Seven unit sizes to 30 hp are available with ratios of 5:1 to 625:1. *Westinghouse Electric Corp.—Booth* 617.

Circle 749 on Yellow Card

6. **Shaft-mounted** speed reducer is available in eighteen models for output speeds ranging from 8 to 425 rpm. Single and double reduction units offer nominal ratios of 4.5:1 and 14.7:1, respectively. *Lovejoy Flexible Coupling Co.—Booth* 537.

Circle 750 on Yellow Card

7. **Permanently lubricated** ball-bearing pillow block has molded synthetic rubber Sentri-Seal for highly efficient sealing with low torque. Shaft sizes range from ½ to 2 15/16-in. *New Departure Div., General Motors Corp.—Booth* 610.

Circle 751 on Yellow Card

8. **Requiring no lubrication,** PowerGrip flexible coupling has three parts: A heat and oil-resistant neoprene sleeve with axially molded internal teeth and two metal end fittings with grooves that match the sleeve's teeth. Six models are for loads to 40 hp at 1750 rpm or torque loads to 1440 lb-in. *United States Rubber Co.—Booths* 738, 740, 746.

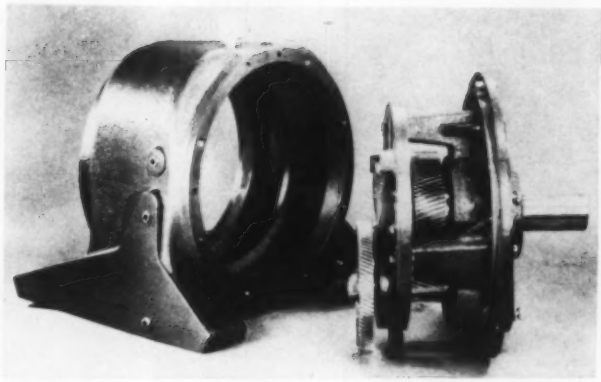
Circle 752 on Yellow Card

9. **Small size** for light-duty applications, model R113 Miter Gear Reducer has 1:1 ratio and horizontal right-angle drive. It weighs 3.75 lb. Rated output ranges from 0.03 to 0.333 hp. *Boston Gear Works—Booth* 554.

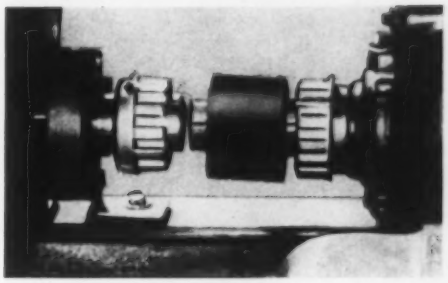
Circle 753 on Yellow Card

10. **Small size-to-capacity ratio** is feature of series 20 line of fin-cooled speed reducers. Single-worm gear reduction, right-angle drive units are for use with motors to 1.5 hp.—*Ohio Gear Co.—Booth* 792.

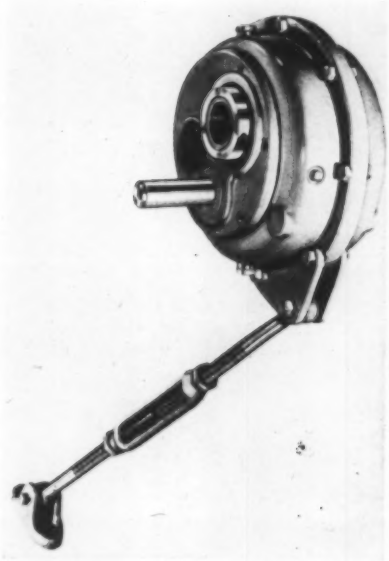
Circle 754 on Yellow Card



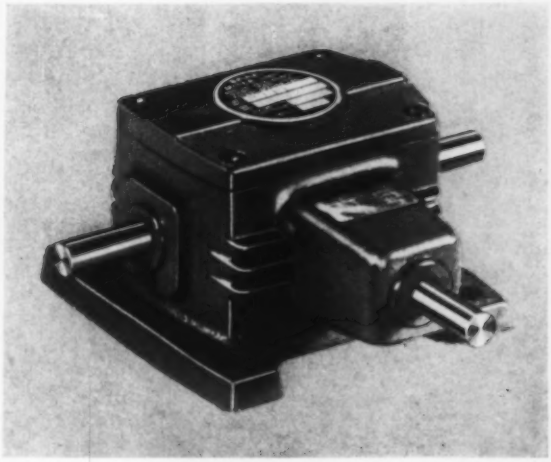
5. Speed Reducer



8. Flexible Coupling



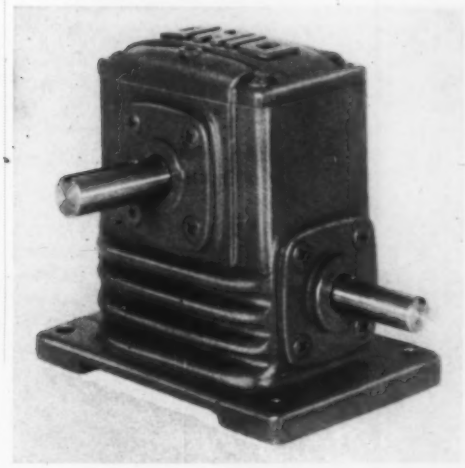
6. Gear Reducer

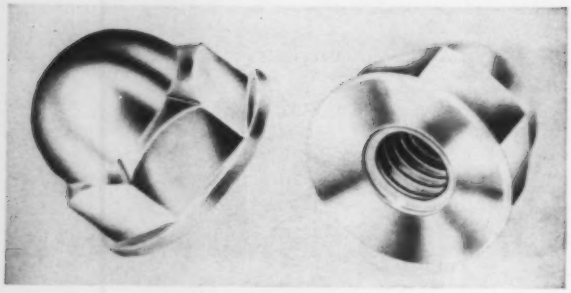


9. Speed Reducer

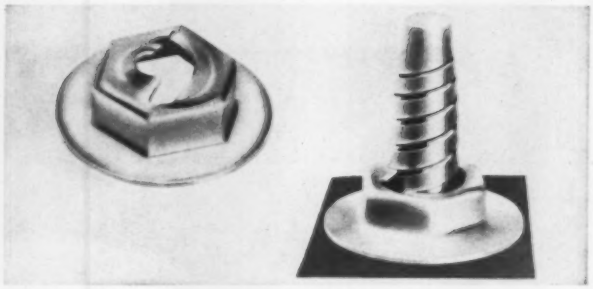
7. Pillow Block

10. Speed Reducer

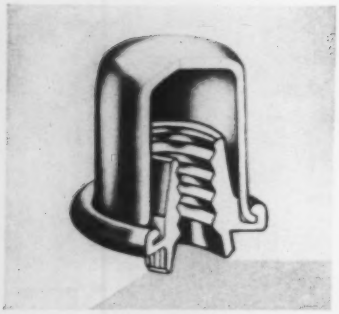




1. Cap Nut

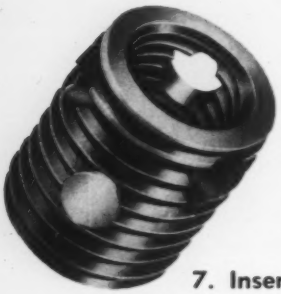


2. Self-Threading Nut

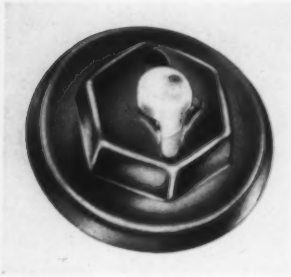


4. Miniature Clinch Nut

5. Wood Screw



7. Insert



8. Sheet Metal Fastener

1. **Integral washer base** of die cast, zinc alloy cap nut provides large mating area and, therefore, a firm grip. Nut can be used on bolts in oversize holes or adjusting slots. Closed-end 3/8 in. hex size is first in new line. *Gries Reproducer Corp.—Booth* 850.

Circle 755 on Yellow Card

2. **Thread forming and tightening** are performed simultaneously by self-threading locknut on straight or tapered unthreaded studs, rods, rivets, and steel, zinc, aluminum, or brass wire. One-piece locknut and washer is available in sizes for 1/8, 3/16, and 1/4 in. unthreaded studs. *Palnut Co.—Booth* 463.

Circle 756 on Yellow Card

3. **Zero-adjustable** coupling allows precision adjustment on sensitive shafts of servomotors, resolvers, and synchros. It is designed for 360-deg continual rotation and adjustment. Four basic shaft sizes are available. *PIC Design Corp. —Booth* 1034.

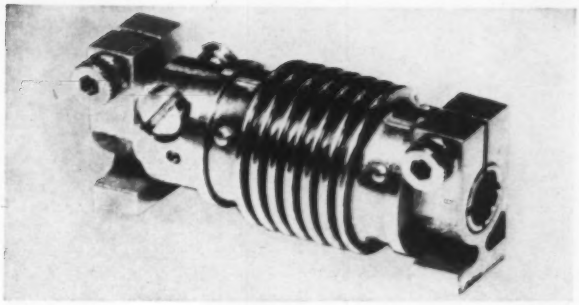
Circle 757 on Yellow Card

4. **Integral metal cap** of self-locking nut protects delicate wiring and components from bolt-end damage in closely packed assemblies; it also prevents potting compound from flowing inside nut threads. Nut is made in 4-40, 6-32, and 8-32 threads with shank length of 0.040 in. *Elastic Stop Nut Corp. of America—Booth* 937.

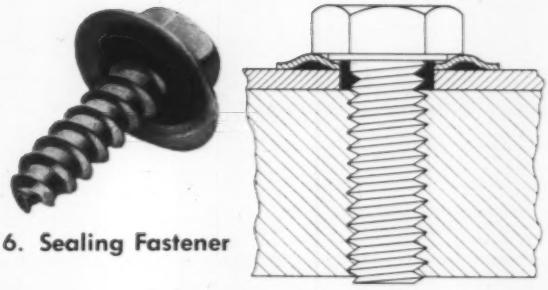
Circle 758 on Yellow Card

5. **Drilling its own hole** as it is driven, Shakeproof Drill Screw eliminates predrilling even in the hardest woods. Various head styles are available in a wide range of screw sizes and lengths. *Shakeproof Div., Illinois Tool Works.— Booths* 522, 524.

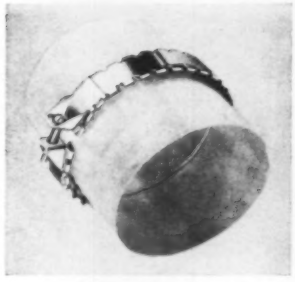
Circle 759 on Yellow Card



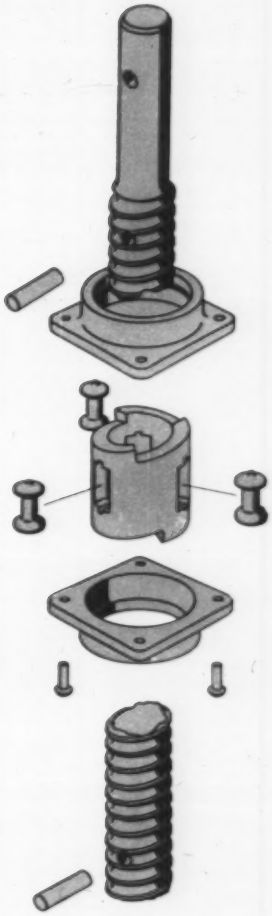
3. Bellows Coupling



6. Sealing Fastener



9. Clamp



10. Antifriction Bearing Screw

6. **Secure triple seal** on irregular, corrugated, or curved—as well as flat—surfaces is provided by Spin-Seal, consisting of washer, flowed-in gasket sealant, and standard machine screw, cap screw, or bolt. Sealant compresses inward, outward, and upward. Screw sizes from No. 6 to ½ in. are available. *Russell, Burdsall & Ward Bolt & Nut Co.—Booth* 986.

Circle 760 on Yellow Card

7. **Self-tapping, screw-locking** Tap-Lok insert locks itself in place; Nylok plug locks the mating fastener to prevent loosening. Insert is made in case hardened cadmium plated steel, stainless steel, and brass.—*Groov-Pin Corp. —Booth* 515.

Circle 761 on Yellow Card

8. **High-torque, high-tensile-strength** fastener is self-threading. It can be used on either plated or unplated steel or zinc die-cast studs and is supplied with or without preassembled sealer. *United-Carr Fastener Corp.—Booth* 422.

Circle 762 on Yellow Card

9. **Only one nut and bolt** closes Ventiduct stainless-steel duct coupling. Joint made by coupling resists vibration. *Marman Div., Aeroquip Corp.—Booth* 305.

Circle 763 on Yellow Card

10. **For efficient conversion** of rotary-to-linear and linear-to-rotary movement, antifriction bearing screw covers a wide range of work loads and power inputs. Dumbbell-shaped antifriction Roton bearings are caged and roll within an annularly grooved nut functioning as the outer race, with the helical thread lead of the screw acting as the inner race. *Anderson Co.—Booth* 538.

Circle 764 on Yellow Card

1. **Nylon and steel** conveyor chain is nonstretching, shock-absorbent, and chemical and corrosion-resistant. Four projections molded onto the underside of each nylon plate function as rivets for fastening to carbon-steel or stainless-steel chain. *Link-Belt Co.—Booths* 983, 987.

Circle 765 on Yellow Card

2. **One-piece construction** of Cable-Strut basket-type tray minimizes friction in pulling cables. Tray is made in aluminum or steel, 3 or 6 in. deep, any width, in a variety of finishes. *Globe Co., Products Div.—Booth* 691.

Circle 766 on Yellow Card

3. **Superiority over aircraft quality** castings is provided by Suparcast process. Company guarantees the following properties in all areas of an AMS 4260 aluminum casting: Tensile strength, 34,000 psi; yield strength, 25,000 psi; elongation, 3 per cent. *Arwood Precision Casting Corp.—Booth* 221.

Circle 767 on Yellow Card

4. **Small, powerful** vibrator is 3 in. diam, 2½ in. high and weighs 3 lb. Standard model V-2 operates at 7200 vibrations per minute and has mechanical adjustment of amplitude of vibration. *Syntron Co.—Booth* 981.

Circle 768 on Yellow Card

5. **Double-bank shutter counter** for navigation or directional instruments and computers indicates latitude or longitude and East-West and North-South, plus-minus, degrees-minutes, etc. *Durant Mfg. Co.—Booth* 1084.

Circle 769 on Yellow Card

6. **Clean, quiet-operating** flat-top conveyor chain requires no lubrication. Rex nylon TableTop chain has hinged-joint design, one-piece platform line and pin construction, smooth beveled edges, and a steady platform with minimum gap between links. *Chain Belt Co.—Booth* 650.

Circle 770 on Yellow Card

7. **Constructed by bolting together** stock components, Alnico V permanently powered units fasten under belt conveyors, transforming them into magnetic conveyor-elevators for rapid handling of ferrous materials and parts up inclines to 90 deg. *Eriez Mfg. Co.—Booth* 1050.

Circle 771 on Yellow Card

8. **Neoprene variable-speed belt** can be specified to any length for use on various drives. It is precision balanced to eliminate vibration. *Manheim Mfg. and Belting Co.—Booth* 444.

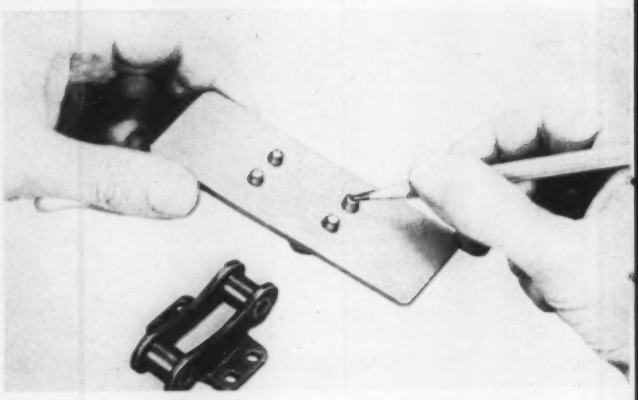
Circle 772 on Yellow Card

9. **Springs made of high alumina ceramic** have high resistance to thermal shock and good dimensional stability over a wide temperature range. Material is a nonconductor. *Diamonite Products Mfg. Co.—Booth* 458.

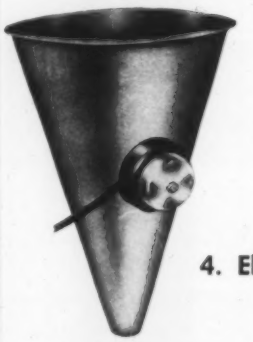
Circle 773 on Yellow Card

10. **Equipment and instrument cabinets** are assembled by means of bolts from frames, panels, and sub-parts. Louvered, perforated, plain, and Formica panels; doors; shelves; and casters are available. *Elgin Metalformers Corp.—Booth* 767.

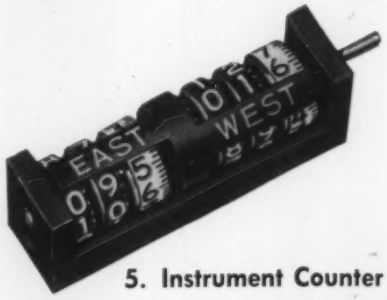
Circle 774 on Yellow Card



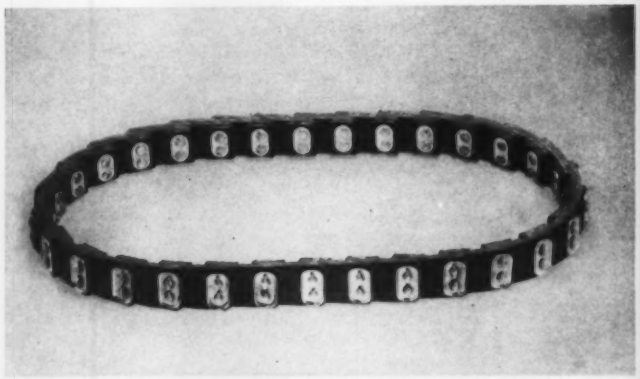
1. Flat-Top Chain



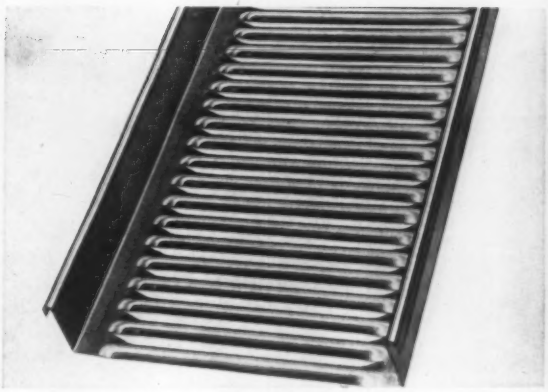
4. Electric Vibrator



5. Instrument Counter



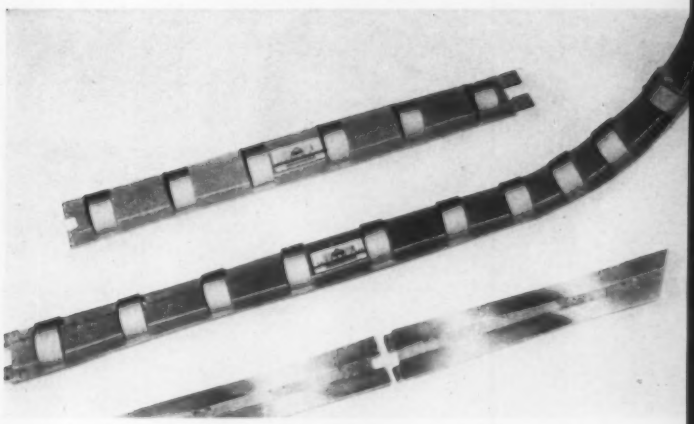
8. Transmission Belt



2. Cable Tray

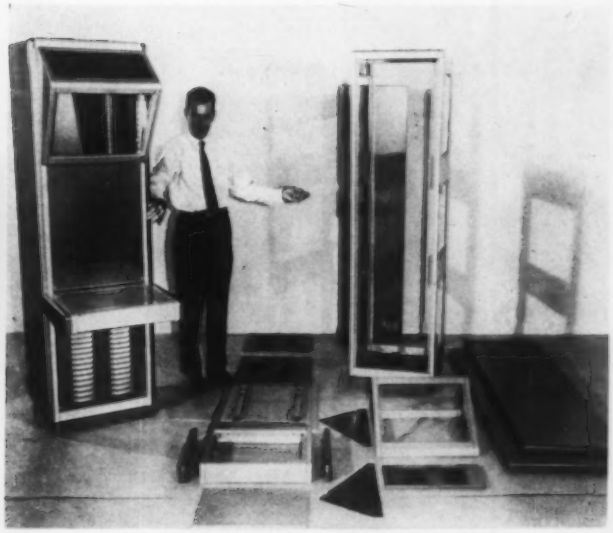
3. Aluminum Castings

6. Conveyor Chain



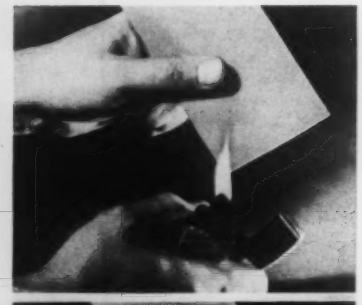
7. Conveyor-Elevators

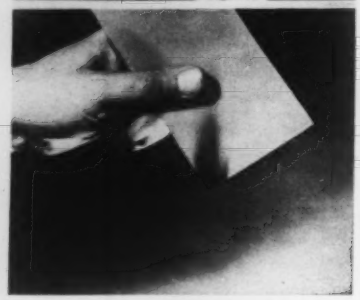
9. Alumina Springs



10. Modular Enclosures

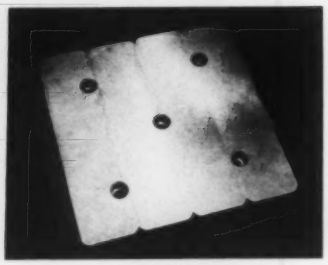
Ideas on Display at the Design Engineering Show



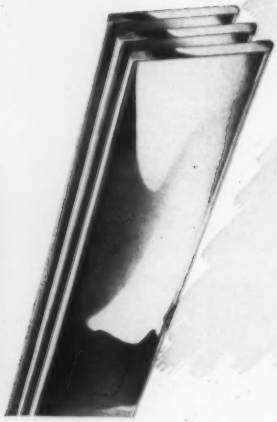


1. Plastic Laminate

2. Glass-Ceramic



3. Combined Powder Metal Parts



4. Aluminum Bus Bar

1. **Excellent electrical characteristics,** flame retardance, and arc resistance are combined in Insurok Grade XT-901 laminate. Properties are unaffected by age or service conditions. Material features low water absorption and low edge and center expansion. It can be fabricated with hot punching equipment. *Richardson Co.—Booth* 914.

Circle 775 on Yellow Card

2. **High mechanical strength,** excellent electrical insulating properties, high deformation temperatures, good thermal shock resistance, and extreme hardness are characteristics of Pyroceram. Heat treatment induces crystal growth, turning material from transparent noncrystalline into opaque crystalline. *Corning Glass Works —Booth* 822.

Circle 776 on Yellow Card

3. **Large powder metal parts** are made by combining smaller parts by means of brazing. Silver solder bonding process permanently joins any number of bearings or parts, such as the four Super Oilite plates combined in the 12 x 12 in. wear plate shown. *Amplex Div., Chrysler Corp.—Booth* 462.

Circle 777 on Yellow Card

4. **Silver-plated aluminum** bus conductor offers a simple, inexpensive method of making reliable electrical connections. Plating adheres absolutely to base metal, preventing blistering and peeling under service conditions; its nonporosity prevents galvanic corrosion of the aluminum. Usually, joints can be made without special preparation of contact areas. *Reynolds Metals Co.—Booths* 824, 826, 828, 925.

Circle 778 on Yellow Card

5. **No lubrication** is required by bearings fabricated from Chemloy. Material is suitable for sliding and rotating service at temperatures to 500 F and for use with solvents and most corrosives. It withstands speeds to 1000 fpm, loads to 100 psi. *Crane Packing Co.—Booth* 555.

Circle 779 on Yellow Card

6. **Color-coded plastic stock,** Plasti-Flex, is supplied in shims, washers, gaskets, etc., made to specification or in roll stock. Gages from 0.001 to 0.030 in. are each identified by a different color. *Auburn Mfg. Co.—Booth* 609.

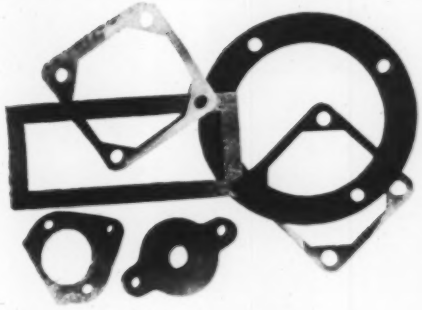
Circle 780 on Yellow Card

7. **Three different size openings** are combined to form Crystal pattern in Multimesh expanded metal. *Penn Metal Co. Inc.—Booth* 962.

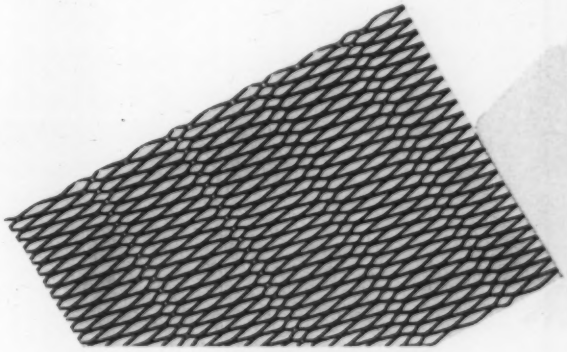
Circle 781 on Yellow Card

MATERIALS

5. Bearing Material



6. Gasket Material



7. Expanded Metal

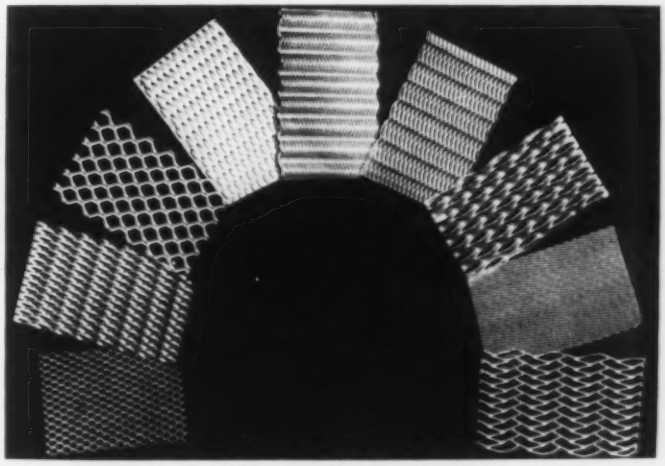
8. Hard-Surfacing Material

8. **Hard cemented carbide,** in the form of small hexagonal plates mounted on adhesive glass fiber backing, can be bonded to metallic surfaces by epoxy adhesives, silver solder, or brazing materials. Kenplate is supplied in strips; hexagons are made in two sizes: 0.210 and 0.425 in. across the flats. Thicknesses are 0.040, 1/16, and ⅛ in. for the former; 1/16, ⅛ and ¼ in. for the latter. *Kennametal Inc. —Booth* 718.

Circle 782 on Yellow Card

9. **Variety of patterns** in Demcor decorative and structural expanded metals have openings from 1/16 to 1½ in. Materials —copper, brass, aluminum, Monel, stainless steel, and carbon steel—vary in gage from 0.015-in. to 12 gage. *Designers Metal Corp.—Booth* 943.

Circle 783 on Yellow Card



9. Expanded Metal

1. Two to four times dimensional stability of unmodified Teflon is inherent in parts molded of Fluorosint. Material's coefficient of expansion is very close to that of aluminum, copper, brass, magnesium, and silver. *Polymer Corp. of Pennsylvania—Booth* 653.

Circle 784 on Yellow Card

2. New patterns of Rigid-tex are supplied in a variety of colors. Ferrous and nonferrous metals are available, solid or perforated. *Rigidized Metals Corp.—Booth* 332.

Circle 785 on Yellow Card

3. Nonporous, 99 per cent aluminum-oxide ceramic, type AD-99, has tensile strength of 34,000 psi. At 2000 F, tensile strength is 20,000 psi. Material has superior dielectric properties. *Coors Porcelain Co.—Booth* 689.

Circle 786 on Yellow Card

Acrylic Molding Powder

Toughness and high impact strength are combined in Implex modified acrylic molding powder. Tensile strength is 5200 psi; modulus of elasticity, 220,000 psi; elongation at break, 30 per cent. Material is stain-resistant. *Rohn & Haas Co.—Booths* 973, 977.

Circle 787 on Yellow Card

Superalloy Tubing

Stability under a stress load of 25,000 psi at 1200 F during a 1000-hr test period is maintained by 16 different superalloy tubing materials. Base metals are iron, nickel, cobalt, and cobalt-chromium-nickel. *Superior Tube Co.—Booth* 628.

Circle 788 on Yellow Card

Preplated Steel

Low-cost, utility grade preplated steel is available in chrome, nickel, and copper finishes. Designated C-grade steel base, material is supplied in sheets, coils, and flat strips in 0.008 to 0.020-in. gages. Standard production processes do not damage finish. *American Nickeloid Co.—Booth* 1038.

Circle 789 on Yellow Card

Insulating Varnish

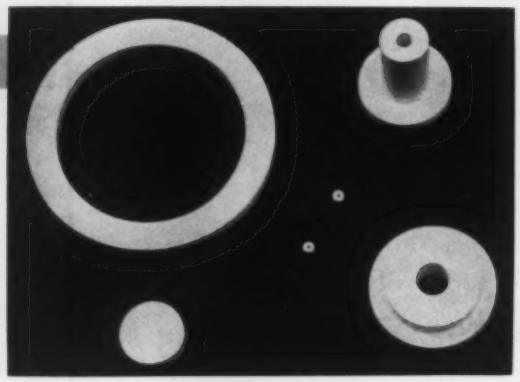
Usable where temperature reaches 155 C, Class F polyester type insulating varnish can be cured at temperatures as low as 125 C. It cures to a tough, flexible film with good adhesive and electrical properties and resistance to oil, moisture and acid. *General Electric Co.—Booths* 872, 874.

Circle 790 on Yellow Card

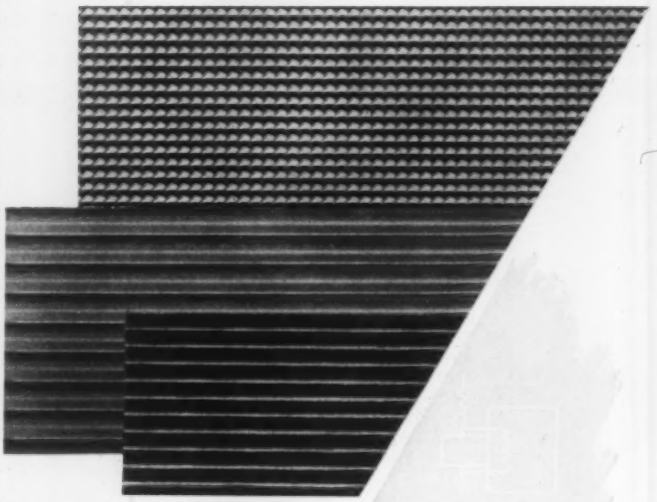
Steel and Copper Bar

Improved machinability—a 10 per cent increase—results from the addition of copper to Stressproof steel bar. Wearability is also improved. Minimum tensile strength remains 100,000 psi in sizes through 2 in. and 90,000 psi in sizes through 3⅜ in. *La Salle Steel Co.—Booth* 601.

Circle 791 on Yellow Card

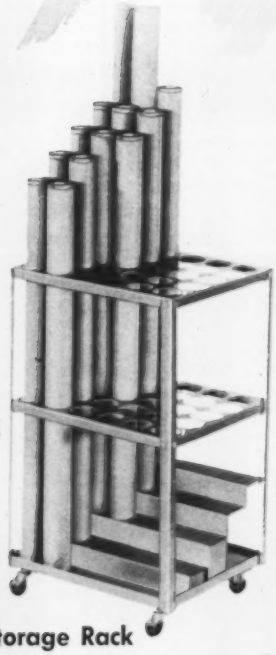


1. Reinforced Teflon



2. Patterned Metal

3. Ceramic



3. Drawing Storage Rack

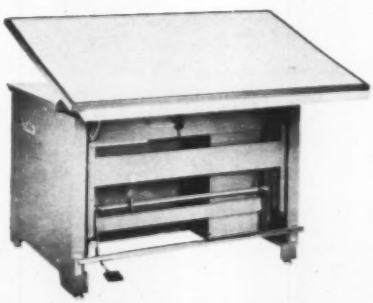
1. Desk-Size Computer

2. Drawing File System

Ideas on Display at the Design Engineering Show

ENGINEERING EQUIPMENT

4. Drawing Board—Desk



5. Drafting Table

1. **Decimal point is positioned automatically** in 610 Auto-Point computer, operation of which can be learned in 1 hr. Data are fed on reels of punched paper tape in larger unit; operator enters variable data into the system through a control keyboard. Operator can type in identifying data as results of computation are produced. *International Business Machines Corp.—Booth* 759.

Circle 792 on Yellow Card

2. **Microfilms of drawings** are mounted in tabulating cards for subsequent reference use in the Recordak engineering drawing system. Cards are punched with all information pertinent to the drawings. In addition to viewing on film reader as illustrated, 35-mm microfilm can be used to reproduce original size or smaller drawings. *Recordak Corp., Subsidiary Eastman Kodak Co.—Booth* 1090.

Circle 793 on Yellow Card

3. **Capacity of 30 or 60 drawings,** blueprints, charts, tracings, etc., is offered by two sizes of Plan-Mobile. Rolled material fits into 2½ in. diam openings and rests on stepped base. *Stacor Equipment Co.—Booth* 803.

Circle 794 on Yellow Card

4. **Concealed mechanism** for vertical and tilt positions is located at one side of Auto-Shift drafting table. New design includes a roll tracing storage bin. Reference surface extends 7½ in. and locks in position. Top sizes are 37½ x 48, 60, or 72 in. and 43½ x 72 in. *Hamilton Mfg. Co.—Booth* 622.

Circle 795 on Yellow Card

5. **Synchronized height adjustment** is controlled by positive-acting counterbalance in May-O-Matic drafting table. Board tilts to any angle from horizontal to vertical. Reference top on rear of table slides forward 10 in. Top sizes of table are 37½ x 48, 60, or 72 in.; 42 x 72 or 84 in. *Mayline Co. Inc.—Booth* 867.

Circle 796 on Yellow Card

Nondestructive Test Coating

Testing at −35 to 700 F can be done with Stresscoat All-Temp. Brittle lacquer coating, sprayed on the part and dried, cracks under load to indicate relative stress concentration. It is fired on parts at approximately 1000 F. *Magnaflux Corp.—Booth* 433.

Circle 797 on Yellow Card

Film-Type Drawing Medium

Strong, transparent, fiber-free Stabilene film line now includes a three-mil grade (0.003-in. base) prepared with a matte coating for all types of pencil and ink drafting. Stability of the film is of the order of 0.000006 in. per in., averaged in both directions, in the range from 80 to 220 F and from 0 to 98 per cent relative humidity. *Keuffel & Esser Co.—Booth* 817.

Circle 798 on Yellow Card

Preview of ideas from the

Design Engineering Conference

FOURTEEN papers, plus a panel discussion, will be presented during the Third Design Engineering Conference. Sessions will be held on the mornings of April 14 through 17 in the International Amphitheatre. Discussions will offer fresh ideas and solutions to a variety of problems faced by the design engineer.

Papers deal with the mechanical, materials, and power and control phases of engineering; the technical information center; and a central catalog file. A panel will discuss putting a design into production.

Sponsor of the Conference is the Machine Design Div. of the American Society of Mechanical Engineers.

Design Engineering Conference Luncheon will feature an address, "Creativeness—Key to Industrial Progress," by Dr. John T. Rettaliata, president of Illinois Institute of Technology. The luncheon will be held at the Stockyards Inn, Tuesday, April 15 at 12:15 p.m.

Conference registration fees — $5 for ASME members and $10 for nonmembers — include a copy of the proceedings.

Monday, April 14—10 a.m.

PANEL DISCUSSION

Putting the Design into Production

Chairman and Moderator: GEORGE F. NORDENHOLT, Former Editor, Product Engineering
Vice Chairman: ARTHUR SOCOLOFSKY, Project Engineer, Acme Steel Co.

LEO KEVITT
Manager of Manufacturing
Instrument and Alemite Div.
Stewart Warner Corp.

JOSEPH MANUELE, Director,
Headquarters Quality Control
Westinghouse Electric Corp.

DONALD L. HARWOOD
Vice President, Purchases
Fairbanks, Morse & Co.

H. WALTER REGENSBURGER
Chief Engineer
General Engineering Dept.
Link-Belt Co.

Tuesday, April 15—9:30 a.m.

MECHANICAL SESSION

Chairman: COLIN CARMICHAEL, Editor, MACHINE DESIGN
Vice Chairman: J. JAMES STONE JR., Chief, Systems Engineering Div., Battelle Memorial Institute

MIREL

Mechanical Memory Devices

ARTHUR MIREL, Assistant Section Manager, General Engineering Laboratory, American Machine & Foundry Co.

A mechanical memory device is usually an arrangement of mechanical components designed to perform a repetitive pattern of useful motion. The motion can be derived from external intelligence or a programmed time sequence incorporated into the design of a mechanism. Criteria to determine mechanical memory must satisfy input or sensing intelligence, selection of a particular element in time, and the mechanical translation. Discussion includes both standard and nonstandard mechanical memory devices and establishes criteria for the various principles.

McCONNELL

Automatic Inspection Devices

DAVID H. McCONNELL, Manager, Autometrology Div., Sheffield Corp.

Improved quality and cost savings are effected by automatic inspection devices; many machine builders incorporate gages and controls as standard equipment. Gaging systems are described, media—pneumatic, electronic, electric, or combination—are explained; examples are given of in-process gages (to measure the workpiece as it is being shaped and to control tool application directly) and post-process gages (to inspect the workpiece after machining and correct or stop the process if parts are faulty).

MATERIALS SESSION

Chairman: HENRY R. CLAUSER, Editor, Material In Design Engineering
Vice Chairman: JAMES E. JOHNSTON, Vice President, Custom Molding Div.., Chicago Molded Products Corp.

RUGGER

Effect of Rate on Tensile Properties of Plastics

GEORGE R. RUGGER, Chief, **E. McABEE** and **M. CHMURA,** Plastics Materials Testing and Specification Unit, Picatinny Arsenal

High-rate data on plastics—results of actual performance tests in the 5 to 15 milliseconds to fracture range—are presented for cellulose acetate, cellulose nitrate, nylon, polystyrene, and polyethylene. Low and high-rate values are given for yield strength, tensile strength, elongation, and modulus of elasticity.

DENNY

Uncommon Engineering Metals

JOHN P. DENNY, Physical Metallurgy Specialist, **LOUIS F. KENDALL JR.,** Nuclear Materials Specialist, General Engineering Laboratory, General Electric Co.

KENDALL

Seven metals with noteworthy properties—formerly ignored because of cost or limited quantity—are brought to the designer's attention. They are zirconium and hafnium (periodic table group IV B); vanadium, columbium, and tantalum (group V B); chromium (group VI B); and rhenium (group VII B). Information on availability, cost, physical and mechanical properties, fabrication, and present and future applications is given for each metal.

POWER AND CONTROL SESSION

Chairman: FRANK J. OLIVER, Editor, Electrical Manufacturing
Vice Chairman: THEODORE A. WETZEL, Chief Engineer, Research and Development, Kearney & Trecker Corp.

RIVOIRA

Electrohydraulic Applications to Machine Tools

EDWARD J. RIVOIRA, Manager, Electrohydraulic and Gaging Div. and **ALBERT A. DALL,** Director of Standard Machine Tool Engineering, Cincinnati Milling Machine Co.

DALL

Selection of machine drives and controls—electric, electronic, hydraulic, pneumatic, or a combination of these types—is guided by accuracy, surface finish, power required, reliability and maintenance, conformity to standards, and duty cycle. The all-hydraulic drive is economically practical in applications requiring wide speed range at low and medium power levels, and smooth operation. Discussion includes an outline of some of the parameters which make up a good machine control system.

MONCHER

Electrohydraulic Control Systems for Aircraft Applications

F. L. MONCHER, Director of Engineering, Aero Hydraulics Div., and **L. D. TAYLOR,** Assistant Chief Development Engineer, Research and Development Dept., Vickers Inc.

TAYLOR

Electrohydraulic control systems meet the increased performance requirements demanded by high-speed aircraft, missiles, and industrial equipment because of inherent small inertia, high speed, low time constant, and high power gain characteristics. Applications of two types of electrohydraulic control systems—servo valves and servo pumps—are explained. Discussion also includes servomotors—permissible motor-to-load ratios; certain servo design parameters for typical hydraulic servomotors; and data relating weights, torques, time constants against horsepower rating for families of electric and hydraulic motors.

Wednesday, April 16—9:30 a.m.

MECHANICAL SESSION

Chairman: C. T. BLAKE, Director of Engineering, Warner & Swasey Co.
Vice Chairman: G. A. NOTHMANN, Manager, Dept. of Mechanical Engineering Research, Armour Research Foundation

FALTOT

Problems in Designing Automatic Machinery

MAURICE J. FALTOT, Assistant Chief Engineer, New Jersey Machine Corp.

Automatic machines are either straight-line, rotary, or a combination of the two. Basic variable design considerations include required floor space, speed of operation, part inertia, and conveying method. Problems in design center about the mechanisms needed to do the required work. These include the conveying system and such mechanisms as indexing, motion, pressure, orientation. Many of the types of motion and methods of holding, moving, and orienting of parts are explained and illustrated.

SKOGLUND

Lubricant Considerations in Centralized Systems

RICHARD D. SKOGLUND, Group Leader, and **ROBERT K. GOULD,** Texaco Research Center, The Texas Co.

Centralized lubrication systems have three basic features: Pump or other positive means of delivering lubricant from a reservoir; distribution system of piping or tubing, and a measuring or metering device to regulate the amount of lubricant applied to each bearing. Discussion covers new developments and factors influencing selection of lubricants, namely suitability of the lubricant for the application and for the dispensing equipment to be used.

MATERIALS SESSION

Chairman: WALTER STARKEY, Associate Professor, Mechanical Engineering Dept., Ohio State University
Vice Chairman: NORMAN E. BATESON, Deputy Director of Research, Pullman Standard Car Mfg. Co.

GOODZEIT

Compatibility of Metals in Bearing Contact

CARL L. GOODZEIT, Senior Research Engineer, General Motors Research Staff

Antiseizure properties are of first-order importance in selecting a journal-bearing combination. Other factors to be considered in choosing bearing material are resistance to fatigue from dynamic loads; corrosion resistance; toleration to dirt, if present, in the lubricant; operating temperature; geometrical configuration; and manufacturing technique and design. Addition of alloying agents and their effect on antiseizure properties are discussed. Examples of bearing selection are given.

DIRKES

High-Strength Structural Sandwich Construction

W. E. DIRKES, Chief, Plastic Products Section, Organic Materials Branch, Wright Air Development Center

Composite materials have found increasing use because material configurations can be adjusted to use the desirable properties of each material. Sandwich construction is a type of composite material; the components of a sandwich panel also may be composite materials. Principal benefit of sandwich construction is greater section modulus per unit of density than a conventional beam or panel of solid material. Selection of components for sandwich construction must be based on consideration of core, faces, and joining medium to assure meeting of design criteria, fabrication techniques, and proposed application.

POWER AND CONTROL SESSION

Chairman: E. M. RAMBERG, Vice President of Engineering, Titeflex Inc.
Vice Chairman: SIDNEY DAVIS, Consulting Engineer

McCANN

Integrating Mechanical and Electrical Design in Servo Systems

WALTER L. McCANN, Assistant Chief Engineer, Giddings & Lewis Machine Tool Co.

Servo-controlled drives must be capable of almost instantaneous response to the controlling signal. Sources that might change or vary the drive response must be considered and compensated for in the mechanical or electrical system. Compromises must be made in mechanical and electrical design to balance the effects of desired machine characteristics. Methods of arriving at and defining the balance needed between the two systems are explained and illustrated.

ERTEL

Solving Mechanical and Electrical Problems in Servo Systems

GLENN ERTELL, Specialty Control Dept., General Electric Co.

Systems composed of electrical, mechanical, and hydraulic elements require particular attention to integration during design to give maximum practical performance at minimum expense. Selection of the components to make up the servo loop can be based on such factors as process to be performed, type of operation, method of motion, characteristics of the elements, physical arrangement, and environment. Integration of design requires consideration of these factors in a logical procedure. Data are given and examples shown to illustrate these and other problems and the solutions necessary for an integrated servo system.

Thursday, April 17—9:30 a.m.

GENERAL ENGINEERING SESSION

Chairman: WILLIAM BUDINGTON, Associate Librarian, John Crerar Library
Vice Chairman: E. H. CANN, Assistant Manager, Graphic Reproduction Sales Div., Eastman Kodak Co.

KENT

The Information Center of Tomorrow

ALLEN KENT, Associate Director, **JAMES W. PERRY,** Director, Center for Documentation and Communication Research, Western Reserve University

PERRY

Development of science and technology has generated an unprecedented flood of new knowledge. Its technological application has become more difficult as traditional library tools for facilitating the availability of recorded knowledge have suffered a serious decline in effectiveness. Documentation will require generation of manuscripts or similar preparation of original documents, distribution of documents, storage to facilitate subsequent reuse, and retrieval of documents from storage—a major problem. Methods are discussed and examples shown of present and proposed means of storing and retrieving engineering and scientific information.

DYKES

A Central Catalog File Saves Engineering Time and Money

JAMES L. DYKES, Supervisor, Commercial Records Management, Engineering Dept., E. I. duPont de Nemours & Co. Inc.

Both large and small companies can use a central catalog file to good advantage. Information is easily available and up-to-date; catalogs are not distributed indiscriminately. Discussion includes the need for engineering catalogs, advantages and disadvantages of a central catalog file, methods of creating such a file, its operation, and cost considerations.

Where to find

DESIGN ENGINEERING SHOW EXHIBITORS

A LARGE part of Chicago's International Amphitheatre will house more than 400 exhibits, containing some 12,000 products, at the 1958 Design Engineering Show. Exhibit area—over 125,000 sq ft—is more than four times the size of the first Design Show.

Hours are noon to 5:30 p.m., April 14 through 17. A registration fee of $2 is payable at the Show. Direct special bus service between major Loop hotels and the Amphitheatre will be maintained during exposition hours.

Exhibitors and their booth numbers are listed here and on the following pages; floor plan of the exhibit area on Pages 184 and 185 facilitates location of exhibitors.

MACHINE DESIGN will welcome visitors at booth No. 112.

A

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Cherry Electrical Products Corp. 309
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Colonial Alloys Co. 587
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Columbus Bolt & Forging Co. 523
Commercial Shearing & Stamping Co. 733
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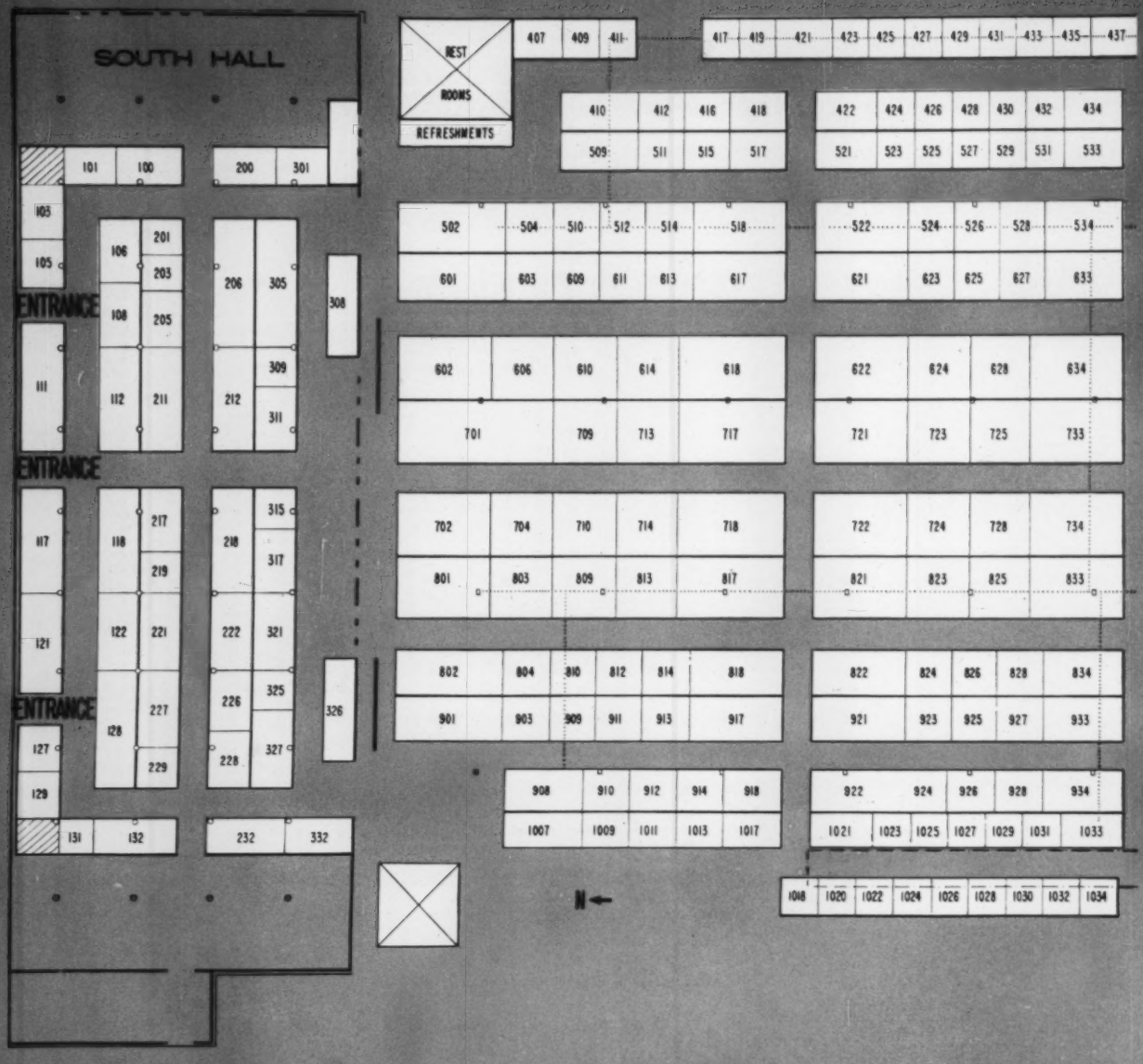

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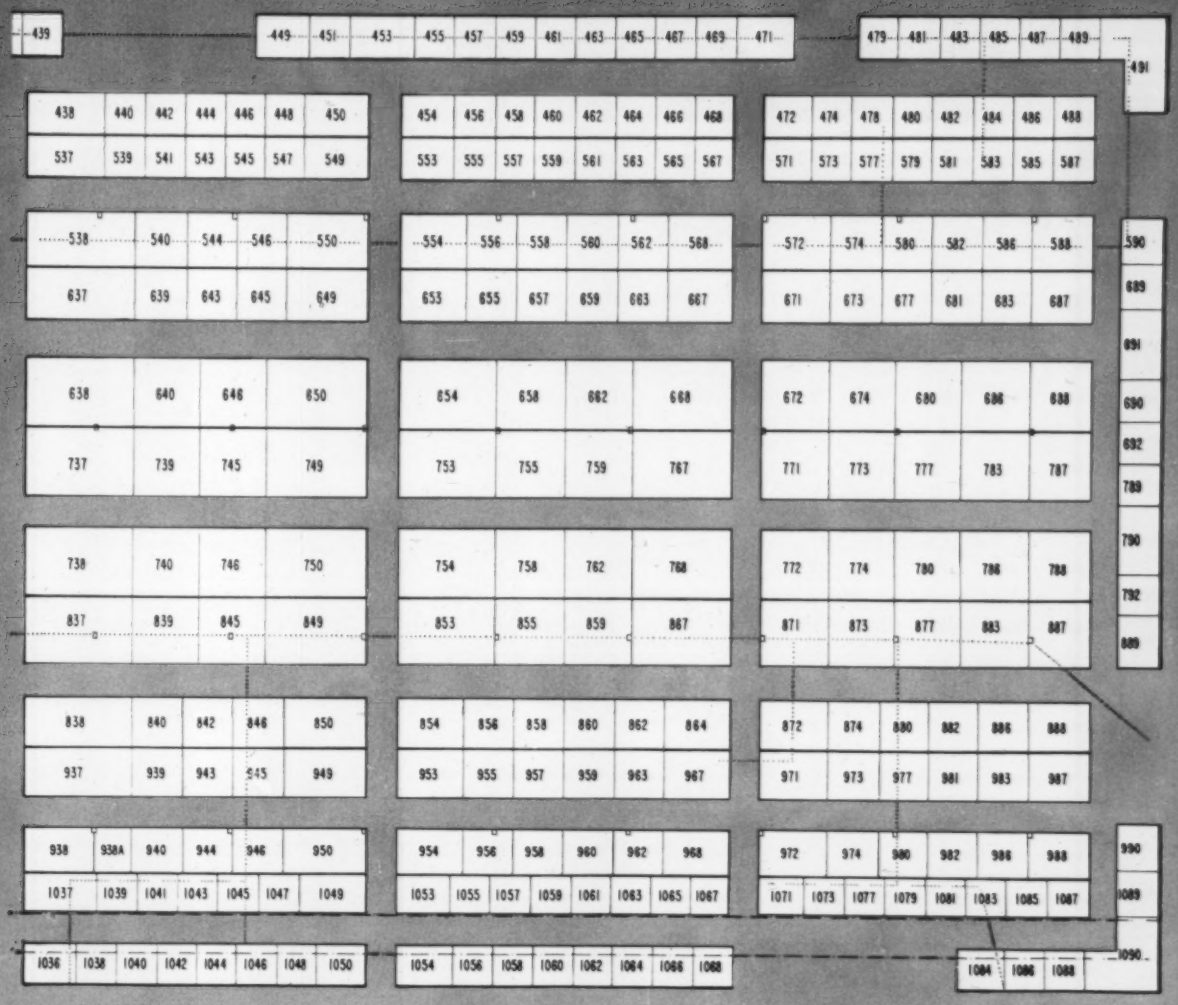

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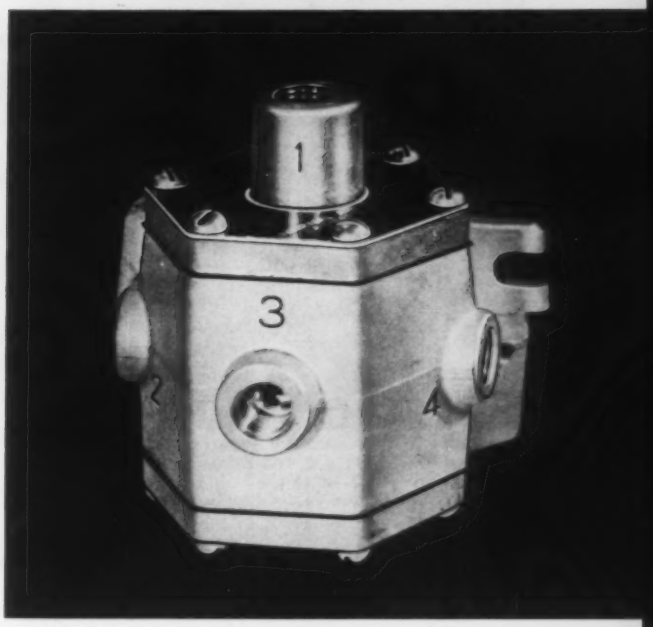


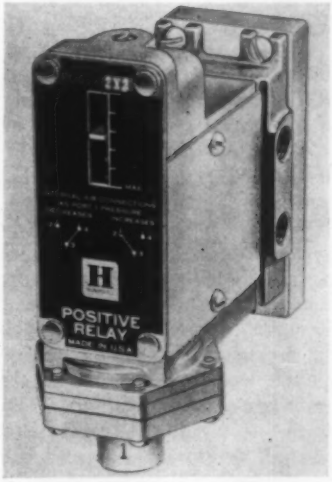
How to use

Pneumatic Relays

By R. R. WEST
Industrial Controls Div.
Minneapolis-Honeywell Regulator Co.
Philadelphia, Pa.

A SIMPLE pneumatic-control system consists of a pneumatic controller and a diaphragm control valve or other air-operated final control element. Output pressure from the controller is applied against the diaphragm in the valve actuator. The valve is positioned by movement of the diaphragm which varies according to conditions sensed by the controller.

Efficiency and flexibility of simple pneumatic control systems can often be increased by installing one of several types of pneumatic relays. In effect, they perform the same



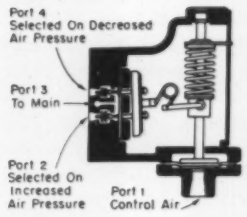
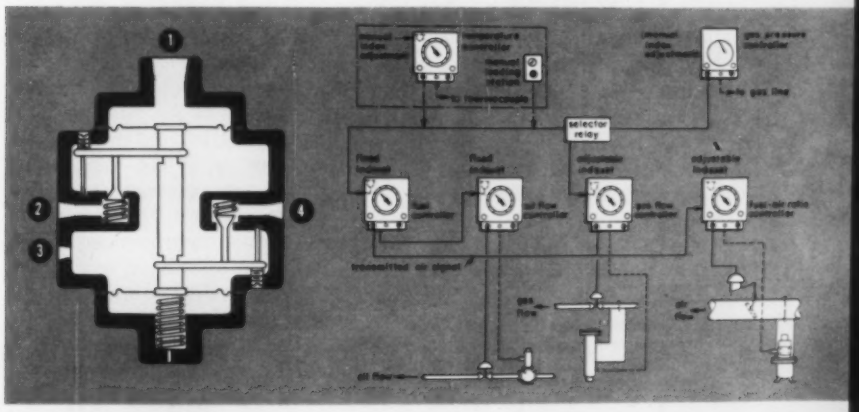


Fig. 3 — Snap-acting diverting relay, or positive relay. Adjustment can be made which causes relay to switch to any selected pressure value within a range of 4 to 17 psi

Fig. 1—Port, diaphragm, and inner valve arrangement of diverting relay. Air flow between ports 3 and 4 takes place with relay in unpressurized condition. Pressure at port 1 closes port 4, opens port 2 and diverts flow from port 4 to port 2

Fig. 2—Selector relay application in fuel-air ratio control system. The relay selects the higher of two pressure signals received from two pneumatic controllers and transmits it to the control valve. Either the gas-flow controller or the oil-flow controller is locked out of the system by response of the relay to a low-pressure signal



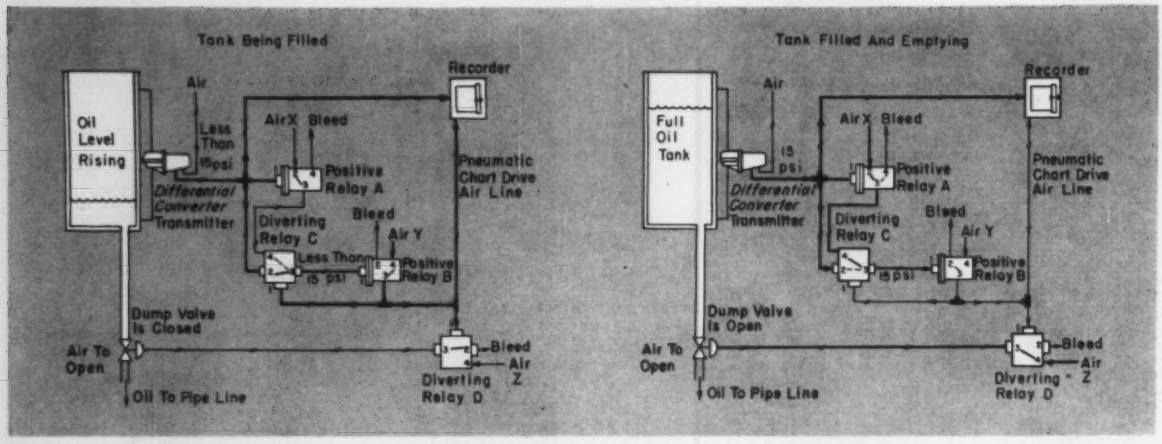


Fig. 4—Left—Diverting relays and positive relays combined in a fully pneumatic system. Relay A is in same position as relay of Fig. 1. The differential converter transmitter signal increases with oil-level rise and causes relay A to switch to position shown. Air X at 15 psi is diverted to port 4 of relay C. Transmitter pressure is also applied to ports 2 and 3 of relay C and to port 1 of relay B. At 15 psi (full-tank pressure), ports 2 and 3 of relay B are connected and chart drive is stopped. Right—At full-tank pressure, ports 3 and 4 of relay C are connected which diverts air X to port 1 of relay B. Ports 3 and 4 of relay D are connected to allow air Z at 15 psi to actuate the dump valve which opens to empty the tank

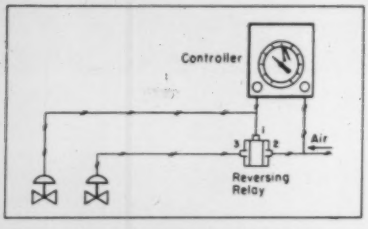


Fig. 5—Reversing relay used to decrease pressure on a final control element as controller's pressure signal increases. Such actuation is required in applications where an increasing output signal must open one valve while closing another

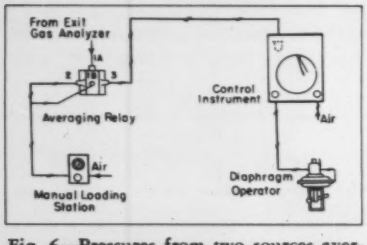


Fig. 6—Pressures from two sources averaged and transmitted by an averaging relay. These relays operate valves by averaging two variables in a system and transmitting to a controller a pressure equal to the average of the two signals

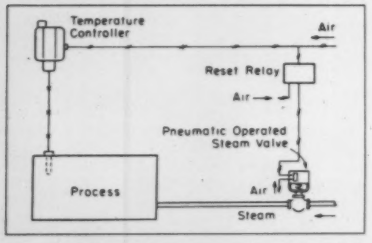


Fig. 7—Automatic reset relay. This device compensates for offset of a proportional controller which results from serious load changes. Rate of reset depends upon rate of air-pressure feedback

functions for pneumatic systems that electric relays do for electric circuits. Pneumatic relays can be used to switch, divert, average, reverse, and select air-pressure signals automatically and in proper sequence.

Diverting Relays: A pneumatic relay consists of a series of pressure-sensitive diaphragms and inner valves which open or close air passages within the relay. Fig. 1 shows the inner construction of a diverting relay. With no pressure at port 1, air flows between ports 3 and 4. If a 15 psi pressure is applied at port 1, the passage between ports 3 and 4 is closed off, and air flows between ports 3 and 2.

Other diverting relays can select the higher or lower of two pressure signals for operating the final control element. In Fig. 2, for example, a selector relay is used in a fuel-air ratio control system where gas and oil are used in combination. Included in the pneumatic circuit is a gas-pressure controller. This instrument measures gas pressure and is interlocked into the system by means of the selector relay. When no gas is available, the relay, responding to the weak signal from the gas-pressure controller, locks out the gas-flow controller. Total input is then provided by the oil-flow controller. When gas is available in unlimited quantity, the selector relay bypasses the oil-flow controller, and total fuel input is supplied by the gas-flow controller.

Nonindicating pneumatic controllers characteristically modulate the air output signal to a control valve. Some applications require two-position operation where a valve must receive 0 psi controlled air pressure for its fully closed position with no intermediate position or modulating action between fully open and fully closed. For these, a snap-acting relay is needed.

A positive relay is a snap-acting diverting relay which operates on a fixed differential of 2 psi adjustable over an entire operative range of 4 to 17 psi on the high side of the differential. Fig. 3 shows inner construction of a positive relay.

System Control: Fig. 4 shows how two diverting relays and two positive relays are installed to control a complex operation. This is a fully pneumatic system for an installation located in an area where electric power is not available. The objective is to fill the tank with crude oil, measure and record the amount of oil in the tank, open the dump valve and shut off the pneumatic chart drive mechanism in a recorder, close the dump valve, refill the tank, and repeat the cycle automatically.

The interesting feature of this installation is that arrangement of pneumatic relays in the system permits the output-air signal from the differential converter (used as a liquid level transmitter) to govern opening and closing of the dump valve and to start and stop the pneumatic chart-drive mechanism.

The differential converter transmitter sends a pressure signal that varies between 3 psi (representing an empty tank) and 15 psi (representing a full tank). In Fig. 4, left, the pressure signal from the transmitter is directed to the recorder where the increasing pressure signal is converted into an indication and record of the quantity of oil in the tank. The pneumatic chart-drive operates only when the tank is filling.

Fig. 4, right, shows changes that take place when oil in the tank reaches maximum level. With a full tank, the transmitter sends a 15 psi signal to port 1 of relay B which causes relay B to switch over, disconnecting ports 3 and 4, and connecting ports 2 and 3. Air bleeds from the chart-drive line, stopping the chart in the recorder. Air also bleeds from port 1 of relay C, causing the relay to switch over and connect ports 3 and 4. This applies air X at 15 psi to port 1 of relay B, locking it in the same position while the tank is emptying. With no air at port 1 of relay D, ports 3 and 4 are connected. This applies air Z at 15 psi to the dump valve which opens and empties the tank completing the half cycle.

As the tank empties, the signal from the differential converter transmitter gradually decreases in pressure until the signal is at 3 psi (empty tank). Relay A again switches over connecting ports 3 and 4. This bleeds air from port 1 of relay B. Relay B switches to the position shown in Fig. 1, and the system is ready for another cycle.

Reversing Relays: A reversing relay operates in conjunction with a pneumatic controller to decrease pressure on a control valve as the controller's output-air signal increases. Such a need occurs where a common increasing output signal must open one valve while closing another. If both valves must close on air failure, the reversing relay, installed as shown in Fig. 5, insures that both valves close even though the relay is receiving an increasing pressure change.

Averaging Relays: When it is required to operate a valve on the basis of the average of two variables, an averaging type pneumatic relay is used. This relay receives two pressure signals and transmits a pressure equal to their average.

An averaging relay installed in a combustion system is shown in Fig. 6. Pressure signals from both an exit-gas analyzer and a manual-setting device are averaged and transmitted to a unit in the controller. This unit automatically positions the set point index of a pneumatic controller. Changes in set point adjustment are reflected in valve operation.

Whenever a process or operation is subject to frequent changes in process load, an automatic reset relay can be installed in the control-air line to compensate for offset. It permits the proportional controller to use as wide a proportional band as necessary for operating stability. The reset relay eliminates about 90 per cent of the offset that would otherwise result.

When a significant load change occurs in a control system, Fig. 7, the reset relay changes control-air output of the proportional controller as required to compensate for offset.

The rate of reset is dependent upon the rate of air pressure feedback. The adjustment is made by positioning a tuning adjustment block to connect one or more tuning elements in the feedback circuit.

From "How to Use Pneumatic Relays," presented in Instrumentation, *Volume* 10, *No.* 6.

Integrated Assembly of

Hydraulic Components

BY E. J. **BROWN**, Chief Engineer, and
S. L. **SANDLEMAN**, Preliminary Design Engineer, Aero Hydraulics Div., Vickers Inc., Detroit, Mich.

HYDRAULIC components and subsystems can be integrated to obtain maximum available power. Since the chief consideration of any system is over-all performance, individual tolerances of components can, in many cases, be relaxed. Through this concept, advantage can be taken of the possibilities offered to achieve over-all performance tolerance with a lightweight, compact, and less expensive package. For a company to integrate valves, motors, pumps, gears, etc. from various component manufacturers, it must establish tolerances for each of the components to arrive at the required over-all system tolerance.

A hydraulic power package which has been integrated, Fig. 1, consists of three basic units: An accumulator-reservoir, an oil-cooled motorpump, and a heat exchanger and blower. Each of these separately has integration advantages. One common housing for the accumulator-reservoir reduces weight and size which otherwise would be required for individual housings for eleven components. There is also a reduction of weight and space, since tubing and fittings of these components are ported within a single housing. Leaks and openings for dirt entry are eliminated, and complete servicing is confined to one panel area.

Further weight and space savings for the integrated oil-cooled motorpump are afforded by an oil-cooled electric motor. Also, the motor fan is eliminated since heat due to inefficiency is dumped into the hydraulic circuit.

The heat exchanger is coupled to the fan for minimum space and integral mounting. It is possible, through integration, to match fan and heat exchanger efficiently with a particular duty cycle. This fa-

cilitates total heat dissipation of the motor, hydraulic package, and external hydraulic circuit.

Weight, space, and cost are minimized by combining electrical harnesses to one common plug-in which facilitates ease of servicing. High response rate of system is achieved through the combined characteristics of the accumulator and pump. In addition, this integrated design permits selection of minimum size motors and pumps since the motor may be slightly overloaded for short duration peak loads without injurious effects.

The integration concept applies to subsystems as well and permits the systems engineer to offer reliable answers to problems of modern hydraulics design. To summarize, results realized are fewer components, minimum line connections, and central installation for simplified maintenance. Other advantages become apparent as each system is surveyed for integration.

From a paper entitled "Optimization Through Integration of Subsystems," presented at the Vickers 7th Annual Aircraft Hydraulics Conference held in Detroit, Michigan, November, 1957.

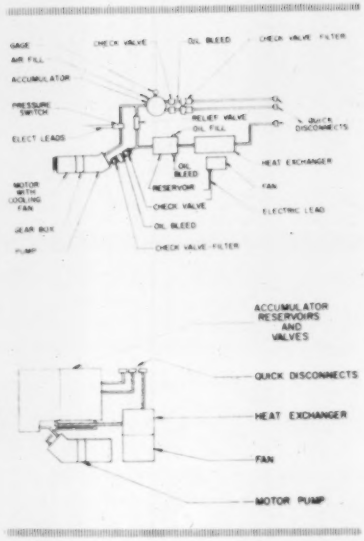


Fig. 1 — Top — Radar hydraulic power package before integration. Eleven components between accumulator and reservoir were combined in one common housing. Bottom—Integrated system composed of basic units. Weight and space savings are evident from a comparative study of the two systems

How to control

Cascaded-Motor Systems

By **PAUL R. GRAVENSTRETER**, Engineering Manager, Package Drive & Control Center Div., The Clark Controller Co., Cleveland, Ohio

CONTROL of dc motors can best be obtained by an adjustable-voltage system. Accurate speed regulation of multiple-drive components is necessary to achieve speeds at which feed rates of materials produce the best products.

To illustrate a system which involves control of multiple-motor drives, Fig. 1 shows three components each driven by a separate motor. Necessity for synchronization of the motors is evident since the components do not operate independently. Speed matching available with this basic system is satisfactory to some extent. However, changes in speed with changes in motor loading and electrical characteristics are inherent in this system. Regulators which detect speed

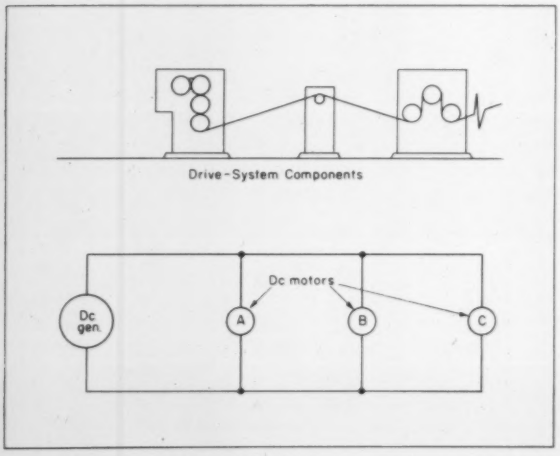


Fig. 1—Basic multiple-motor drive system. Speed match available with this system is satisfactory but has inherent negative factors which influence its acceptability. Change in speed with change in motor loading is a major factor which makes the system unsuitable and in need of control

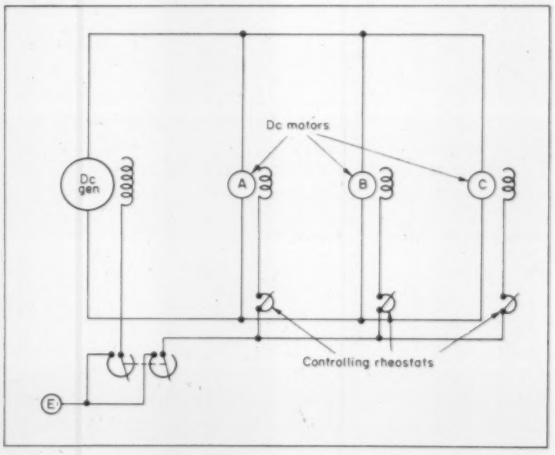


Fig. 2—Addition of controlling rheostats to basic system. Manual adjustment of motor speed is possible but requires operator's attention. Although improved, the system lacks economical advantages of those under control of automatic regulators which eliminate manual adjustment

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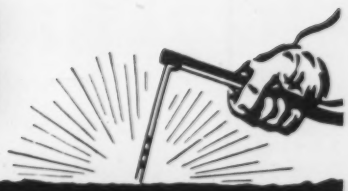

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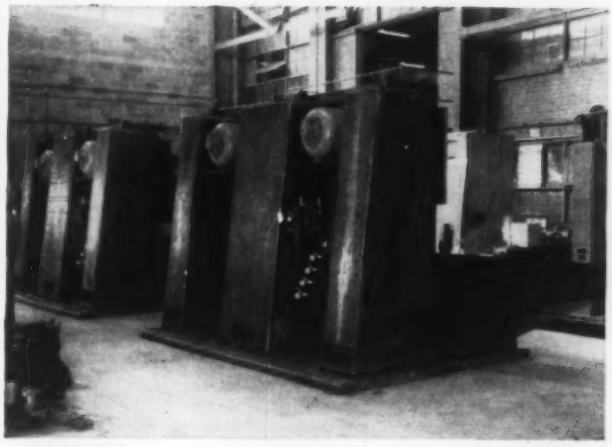

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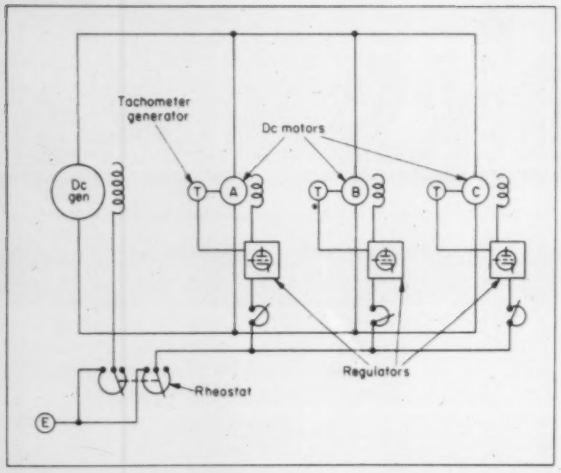

Fig. 3—Installation of regulators in basic drive-system. Undesirable characteristics of this system include speed matching not governed by generator voltage, and loss of motor torque with speed increase. Also, change of speed of drive A is not tied to drives B and C

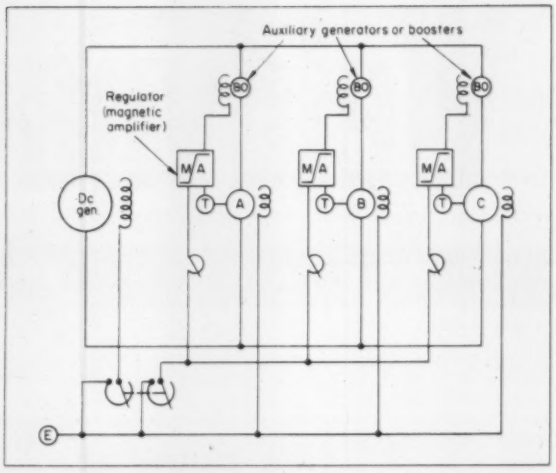

Fig. 4—Auxiliary generators, or boosters, adjust voltage of each of the motors. Motor speed, when changed, is the algebraic sum of main-generator voltage and booster voltage. The booster supplies voltage required for draw and correction voltage for smooth operation

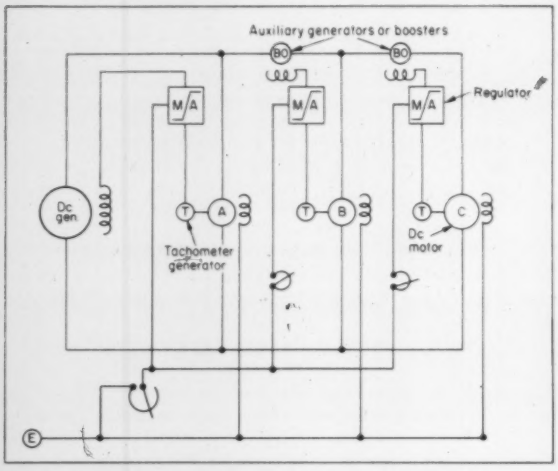

Fig. 5—Condition of voltage dependence on preceding motor drive achieved by cascading the boosters. The term "cascade" describes the feature of speed regulation of a motor based on a constant percentage of the speed of the preceding motor

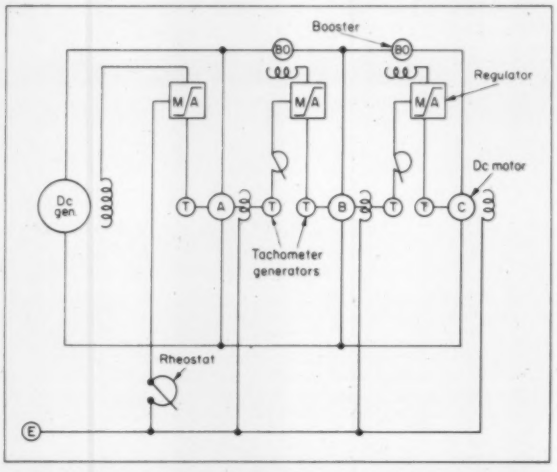

Fig. 6—Magnetic amplifier regulators comparing tachometer-generator voltages of two drives. With this system, each drive is completely dependent on the preceding drive for speed, voltage, and draw. Inaccuracy of such a system cannot be less than 0.1 per cent as component accuracy limit is reached

changes due to load and time factors are used to control motor speed.

Regulators: Three general types of regulators are available: Rotating, electronic, and magnetic or static devices. The regulator senses a change in input characteristics and, in turn, delivers an output of workable magnitude to alter a circuit and defeat original input change. These regulators may be applied in a number of different ways to gain various degrees of motor control.

Fundamental components of Fig. 1 are shown in Fig. 2 as a system without regulation but with manual adjustment. Here, speed change from the two troublesome factors, load and temperature, is compensated for by the operator through adjustment of motor-field excitation with a simple rheostat. This system lacks the economical advantages of those under control of automatic regulators.

Fig. 3, again showing the basic components, offers a partial solution to the control problem. However, the following undesirable characteristics, not particularly self-evident, are inherent in the system:

1. Speed match is not by generator voltage, but by motor field nonlinear with excitation.
2. Motor torque is lost as motor speed is increased.
3. Change of speed of drive A is not tied to drives B and C.

Auxiliary Generators: To make the proposed system operate as required, further modification of the general system is necessary. One of the problems can be overcome by addition of auxiliary generators to adjust voltage of each of the motors. General speed may be set by

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HALOID XEROX®

Circle 496 on Page 19

adjustment of the main generator, as in Fig. 3. Motor speed, when changed, is changed by adjustment of motor terminal voltage. However, this system still has disadvantages. Speed of any motor in the system should follow the speed of the preceding motor but still be adjustable itself. The system of Fig. 4 provides this feature but fails to utilize the equipment to its best advantage. Speed, voltage, and draw or speed adjustment, all of which are related, must be correctly derived. Derivation of speed sense from the preceding drive is not enough since voltage and draw are also related to speed. Specifically, each of these quantities should be measured on the preceding drive and used to control the following drives. Equipment of Fig. 4 is a compromise of the ultimate and most desirable scheme.

Fig. 5 represents another step toward the ultimate system. In the preceding figure, only one of the three factors, speed, was made available to the following drive. Voltage and draw must still be considered. As shown in the network of Fig. 5, the condition of voltage dependence on the previous drive is available. Each booster permits the voltage reference for the following drive to be determined by the preceding drive. The booster compensates for load and temperature changes as they occur and also serves to supply a means of adjustment for draw. The heavy-current armature circuit provides synchronizing forces by virtue of low-resistance paths in the complete system. This scheme allows circulating currents to force speed synchronization.

In Fig. 6, regulators compare tachometer generator voltages of two drives. The speed pattern is now reflected in the proper form, and each drive is completely dependent on the preceding drive for speed, voltage, and draw. By this arrangement, it is possible to provide what might be considered an almost perfect drive. Drive tracking is estmiated to be less than 0.25 per cent over a wide speed range.

From a paper entitled "New Types of Calendar Drives," presented at the 8th Annual Conference of Film, Sheeting, and Coated Fabrics Div. of the Society of the Plastics Industry Inc. in New York, December, 1957.

Using protective atmospheres for

High-Temperature Bearing Operation

By C. H. BAILEY, S. S. SOREM, and A. G. CATTANEO, Shell Development Co., Emeryville, Calif.

THERE appears to be no metallurgical reason why rolling-element bearings made of tool steel cannot operate satisfactorily to at least 1000 F. Organic fluids currently used for lubrication limit operating temperatures to approximately 500 F. Inorganic fluids, such as molten metals and solid lubricants, are receiving considerable attention as possible high-temperature lubricants.

Bearings operated in a protective atmosphere do not require any lubricant. The bearing is surrounded with a reducing atmosphere which is piped into the housing to prevent destructive oxidation, and lubricating films are formed on bearing surfaces by means of reactive compounds added to the reducing atmosphere.

To date, test runs of 100 hr at 700 F, and 22 hr at 840 F have been completed with no signs of impending bearing failure.

Dry-Bearing Operation: A number of mechanical details must be carefully controlled before operation in the dry condition can be accomplished successfully. It is necessary to "break in" bearing surfaces by operating for a short period with oil lubrication before dry running. Bearing fit, alignment, and cage balance are somewhat more critical when running dry than when running with oil.

Extreme-Pressure Additives: Volatile compounds containing sulfur, phosphorus, or halogen are effective in minimizing scuffing or metal pickup on rubbing surfaces of the cage when added to the reducing atmosphere. Test results show that protective functions of a conventional liquid lubricant which permit a rolling-element bearing to operate without excessive surface deterioration can be performed at elevated temperatures by a properly designed vapor mixture. This method of bearing operation is called "protective atmosphere" operation.

Materials: Metals which do not work well in a protective atmosphere include corrosion and oxidation-resistant metals such as Monel, Inconel, and stainless steel. It is believed that the tenacious and impervious oxide films which are responsible for their corrosion resistance also prevent formation of the type of films essential to protective-atmosphere operation. These oxide films also induce high friction.

To summarize briefly, the protective-atmosphere method for operating rolling-element bearings at high temperature involves:

1. Surrounding the bearing with a reducing atmosphere to prevent destructive oxidation of bearing parts during operation.
2. In-place formation of lubricating films on bearing surfaces during operation. For best results, these films should include both the reaction product of an extreme-pressure element with the bearing surfaces and an organic-composition film.
3. Metals of bearing construction must have a positive oxidation potential to accept the films.

From a paper entitled "Protective Atmospheres for High-Temperature Bearing Operation," presented at the SAE Annual Meeting in Detroit, Mich., January, 1958.

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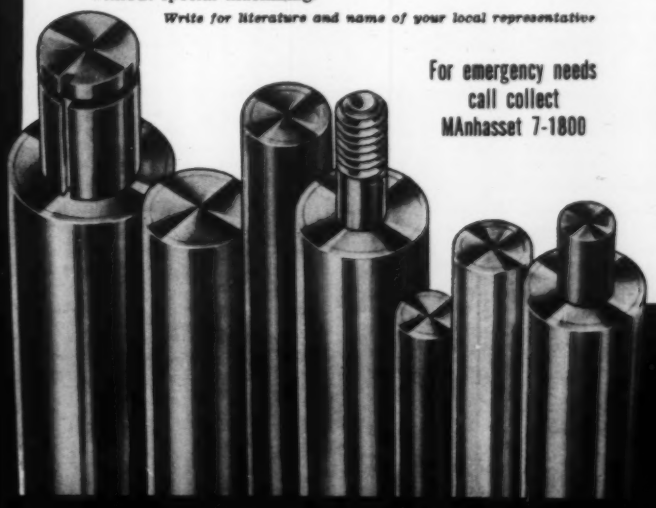

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Circle 497 on Page 19

Helpful Literature for Design Executives

For copies of any literature listed, circle Item Number on Yellow Card — page 19

Temperature Control

An electronic temperature control, designed for aircraft use, is briefly described in Data Sheet F-8518. Wiring and dimensional diagrams are included. 2 pages. Barber-Colman Co., Aircraft Controls Div., Rockford, Ill. K

Circle 799 on Page 19

Plastics

Brief facts about industrial applications for the principal plastic families are contained in folder. They are described as a category of engineering materials. 4 pages. Cadillac Plastic & Chemical Co., 15111 Second Ave., Detroit 3, Mich. H

Circle 800 on Page 19

Industrial Ovens

Power-O-Matic control that automatically proportions minimum wattage input in relation to operating temperature and work load is a feature of industrial patch ovens described in illustrated Folder 5510-A. Specifications and applications of these and other models are given. 4 pages. Soiltest Inc., 4711 W. North Ave., Chicago 39, Ill. I

Circle 801 on Page 19

Printed Circuit Connector

Bellows-action contacts that accept printed circuit board thicknesses from 1/16 to 1/8 in. are a feature of Series 600-93 printed circuit connector. A 15-contact size is described in illustrated bulletin. DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y. D

Circle 802 on Page 19

Custom Plastics Molding

Molding and finishing facilities for custom plastic parts production are outlined and illustrated in brochure. Electrical switchgear components, radio parts, instrument housings, ground wood molding, and other parts are covered. 8 pages. Insulation Mfg. Co., 11 New York Ave., Brooklyn 16, N. Y. D

Circle 803 on Page 19

3000-psi Pump

Rotation in either direction, six inlet and outlet positions, replaceable valve seats, and spring-loaded shaft seal are features of a 3000-psi Model P piston pump, subject of Data Sheet G-2. Maximum speed is 1200 rpm. 2 pages. Brand Hydraulics, 144 S. 38th St., Omaha 31, Nebr. I

Circle 804 on Page 19

Power Amplifier

Advantages, uses, specifications, and a description of the X-band pulse-CW power amplifier are presented in data sheets. Operation is at 8000-9600 mc, or comparable bandwidth as specified up to 12,000 mc. Optional features are also covered. 4 pages. Resdel Engineering Corp., 330 S. Fair Oaks Ave., Pasadena, Calif. L

Circle 805 on Page 19

Vibration & Shock Mounts

Vibration and shock mounting systems for airborne electronic equipment and other components are described in Bulletin F1A. Variable-damped engineered mounting systems are discussed, as are various standard component parts. 4 pages. Federal Shock Mount Corp., 1060 Washington Ave., New York 56, N. Y. D

Circle 806 on Page 19

Electronic Generators

Two types of time delay generators and four basic types of pulse generators with several modifications are described in illustrated Short Form Catalog R-723. Specifications and prices of all models are given. 4 pages. Rutherford Electronics Co., 8944 Lindblade St., Culver City, Calif. L

Circle 807 on Page 19

Hydraulic Pumps

Catalog Section 109 is filled with design and performance data on bronze-constructed positive-displacement pumps for lubrication, hydraulic power transmission, liquid transfer, and other services. These pumps are of rotary internal gear type in capacities to 47 gpm at 400 psi. 4 pages. Tuthill Pump Co., 939 E. 95th St., Chicago, Ill. J

Circle 808 on Page 19

RF Filters

Line of "custom" RF filters, stocked for off-the-shelf delivery, is listed in new catalog. Wide variations in size, shape, voltage, and current ratings are offered. 4 pages. All-Tronics, Inc., 45 Bond St., Westbury, L. I., N. Y. D

Circle 809 on Page 19

Solenoid Valves

"Facts to Remember About Solenoid Valves" is a letter which discusses various factors concerning these controls and their use in automatic operation. 4 pages. Atkomatic Valve Co., 545 W. Abbott St., Indianapolis, Ind. J

Circle 810 on Page 19

Wire & Cable

Illustrated brochure "Turbo Wire & Cable" deals with specifications and application information on military hook-up, silicone rubber insulated, coaxial, aircraft, multiconductor, and UL-approved wire and cable. Ask for Bulletin TWC 57. 6 pages. William Brand & Co., Willimantic, Conn. B

Circle 811 on Page 19

Electro-Mechanical Components

Thirteen specialized valves, solenoids, and switches which have been developed for vehicular or aviation purposes are cataloged in illustrated bulletin. Company can provide complete production, testing, and inspection facilities for making electro-mechanical components. 26 pages. Koontz-Wagner Electric Co., 516 N. Michigan St., South Bend, Ind. J

Circle 812 on Page 13

Alloy Tubing

Small diameter, super-alloy tubing for applications requiring strength at high temperature is subject of Bulletin 70. Materials will not rupture under a stress load of 25,000 psi at temperatures to 1200° F during a 1000-hr test period. They also resist oxidation and corrosion. 10 pages. Superior Tube Co., 1578 Germantown Ave., Norristown, Pa. C

Circle 813 on Page 19

Platinum Products

Dimensions and application data on a complete line of platinum crucibles, evaporating dishes, electrodes, laboratory equipment, microchemistry apparatus, and other platinum ware are presented in illustrated catalog. 24 pages. J. Bishop & Co., Malvern, Pa. C

Circle 814 on Page 19

Globe Valves

Described in Bulletin B-2 are globe valves with 600, 1500, and 2500-psi ASA ratings in Monel or corrosion resistant constructions. Sectional drawings show design features. 20 pages. Associated Valve & Engineering Co., 1150 W. Marquette Rd., Chicago 21, Ill. J

Circle 815 on Page 19

Clear Plastics

Six special clear plastic materials and a coating material for emergency repairs are described in bulletin on Homalite plastics. Products resist corrosion, abrasion, crazing, temperature changes, and shattering. 6 pages. Homalite Corp., Wilmington 4, Del. C

Circle 816 on Page 19

Washers

Dimensions, prices, and finishes of standard and special washers are contained in 1958 catalog. Included are useful weight

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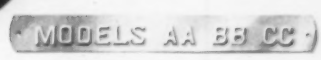

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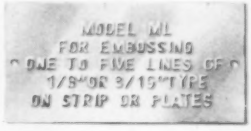

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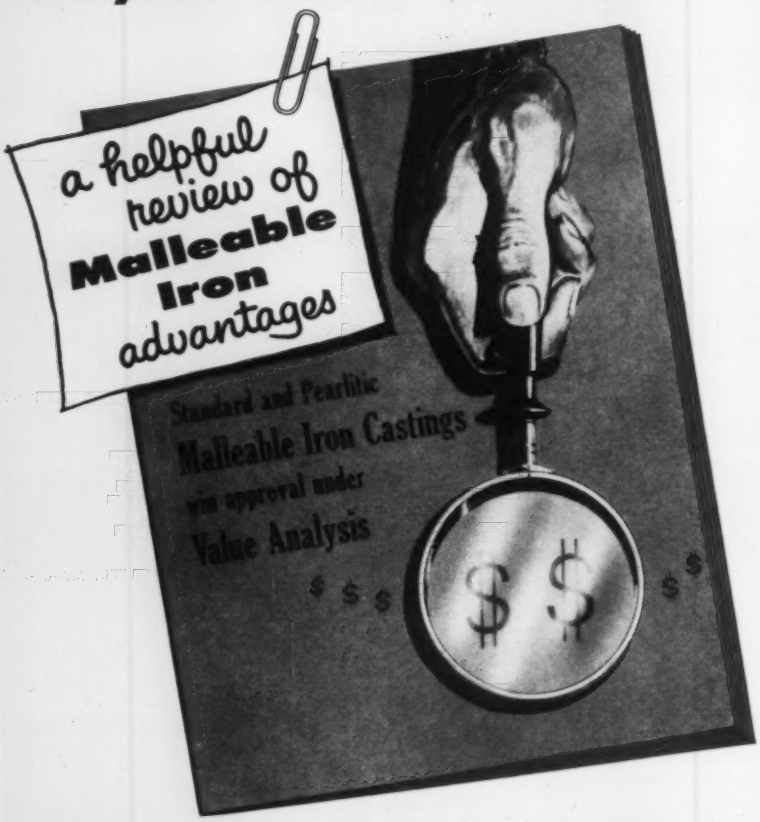
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and diameter tables, gage data, and decimal equivalents. Sections list sizes and thicknesses of Belleville, flat, square, round, hardened, bevel, and spring lock washers as well as expansion plugs, caster shims, and machinery bushings. 16 pages. Joliet Wrought Washer Co., Joliet, Ill. I

Circle 817 on Page 19

Special Fasteners

Hinge-Lock, spring loaded Link-Lock, Dual-Lock, Quick-Lock, Roto-Lock, and Spring-Lock fasteners are some of the special types described with specifications, engineering drawings, applications, and installation information in illustrated catalog. 40 pages. Simmons Fastener Corp., N. Broadway, Albany 1, N. Y. D

Circle 818 on Page 19

Packing Material

Anchor Pak is a corrugated interior packing material that combines adhesive and cushioning qualities. Small parts will adhere directly to the packing. Details on applications are given in bulletin. 4 pages. Hinde & Dauch, Sandusky, Ohio. G

Circle 819 on Page 19

Self-Sealing Fasteners

Illustrated Bulletin 256 describes Tuff-Tite screw and neoprene washer assemblies which combine sealing and cushioning effect to create tight fastening and to avoid marring of highly finished surfaces. Truss, pan washer, and hex washer head types are offered in sheet metal screws and bolts. 4 pages. National Screw & Mfg. Co., 2440 E. 75th St., Cleveland 4, Ohio. F

Circle 820 on Page 19

Speed Reducers

Engineering Manual B-7224 presents selection, hp ratings, torque capacity, overhung load values, dimensions, construction details, and installation and maintenance information on the new Moduline speed reducers. Double, triple, and quadruple reduction units are available in horizontal, right-angle, and vertical models with ratings from 1 to 75 hp. 32 pages. Westinghouse Electric Corp., Gearing Div., Nuttall Plant, Pittsburgh, Pa. F

Circle 821 on Page 19

Contour Projectors

Optical gaging in the toolroom, production line, receiving, and final inspection with Kodak optical contour projectors is discussed in bulletin entitled "Kodak Optical Projectors." Machines and accessories are described. 16 pages. Eastman Kodak Co., Apparatus & Optical Div., Rochester 4, N. Y. F

Circle 822 on Page 19

Fasteners & Precision Parts

Over 10,000 types of solid rivets, cold formed parts, blind rivets, self-tapping screws, locknuts, formed wire parts, lockbolts, and Tuff-Tite fasteners are among the cold headed fasteners and small parts detailed in illustrated guidebook. Design

Circle 499 on Page 19

DE LAVAL
IMO PUMPS

are now more versatile than ever

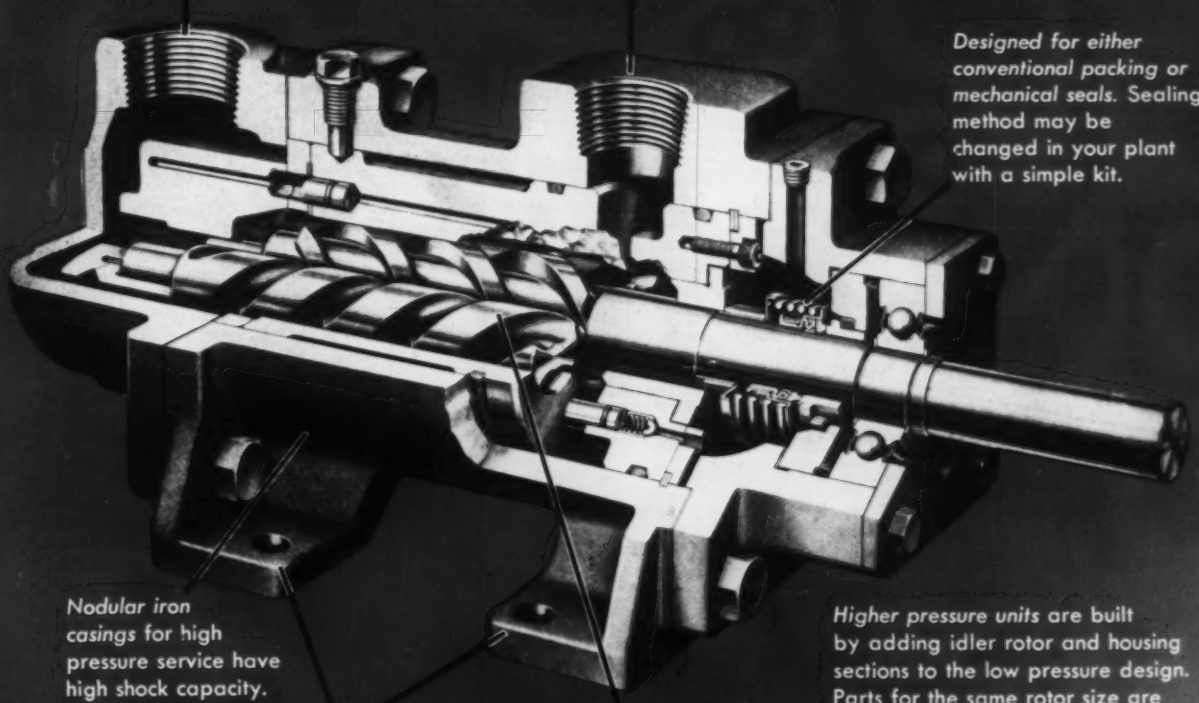
De Laval IMO pumps have proved that they do a dependable job over long years of service. The reason is IMO design simplicity. These constant displacement rotary pumps have only three moving parts—smoothly intermeshing rotors that propel the fluid axially in a steady flow without churning, pocketing or pulsation. There are no timing gears, cams, valves, sliding vanes, or reciprocating parts to wear or become noisy. *Quiet*, compact IMO pumps are excellent for direct-connected, high-speed operation.

In addition to these basic pumping advantages, the improved IMO gives you important new benefits shown in the cutaway illustration below.

Inlet can be rotated to suit installation arrangement.

Discharge flanges are infinitely varied. You can use the most advantageous piping method to suit installation requirements.

DE LAVAL IMO PUMPS can also be used as hydraulic motors.



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Higher pressure units are built by adding idler rotor and housing sections to the low pressure design. Parts for the same rotor size are ipterchangeable over the entire pressure range.

Any position mounting is possible without factory modification.

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Bulletin 3001 gives data on improved De Laval IMO pumps. Send for your copy today.

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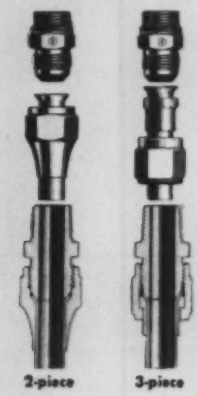

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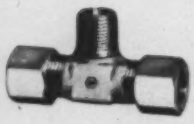

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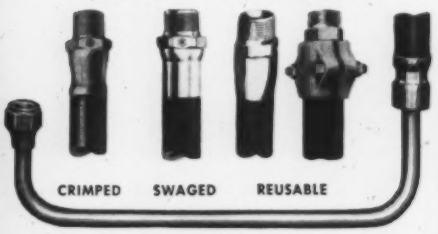

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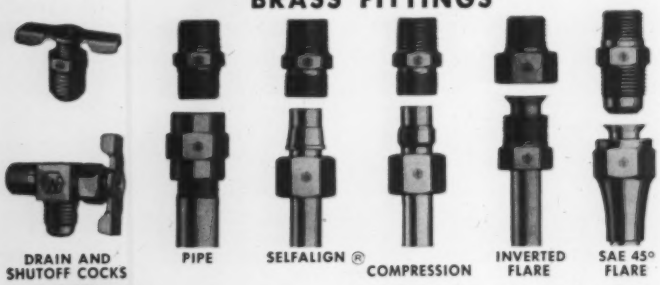

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and production facilities and personnel are described. 50 pages. Townsend Co., New Brighton, Pa. G

Circle 823 on Page 19

Limit Switches

Type DM heavy duty limit switches with 10-amp contact ratings for 110 to 600 v ac or dc service are subject of Bulletin 102DM. Design and operating features of these lever-operated controls are shown with sectional pictures. 4 pages. Clark Controller Co., 1146 E. 152nd St., Cleveland 10, Ohio. F

Circle 824 on Page 19

Welded Parts & Assemblies

"Rings, Bands, and Welded Assemblies" is title of illustrated guide to products and services offered by this company. Both standard and custom fabrications produced to user's needs are described. Case histories show production and cost savings. 20 pages. American Welding & Mfg. Co., Industrial Products Div., 101 Dietz Rd., Warren, Ohio. G

Circle 825 on Page 19

Ceramic Materials

Physical properties of Crystolon N nitride-bonded, Crystolon R recrystallized or self-bonded, and Crystolon C coating ceramic materials are described in Technical Bulletin 686 NP 1. Materials have high resistance to thermal shock and extreme temperatures. 8 pages. Norton Co., Worcester 6, Mass. B

Circle 826 on Page 19

Power Chucking Equipment

Specifications, dimensional drawings, and design information on power chucking equipment are contained in illustrated Catalog 112. Covered are power chucks, rotating air and hydraulic cylinders, air valves, and accessories. 32 pages. S-P Mfg. Corp., 30201 Aurora Rd., Solon, Ohio. G

Circle 827 on Page 19

Hoses, Assemblies, Fittings

Flex-O-Tube hose, hose assemblies, and re-usable hose fittings are subject of illustrated Catalog C-100. Dimensional data are given for each of the various types of products offered. Assembly instructions are included. 24 pages. Flexonics Corp., Flex-O-Tube Div., 2525 Jim Daly Rd., Inkster, Mich. J

Circle 828 on Page 19

Centralized Lubrication

System planning data for the Accumite centralized lubrication system are presented in Form 34-28A. Detailed are analyses of machine bearings; selection of lubrication interval, system components, and lubricant; and installation procedure. 12 pages. Stewart-Warner Corp., Alemite Div., Chicago 14, Ill. J

Circle 829 on Page 19

Adhesives, Coatings & Sealers

How 3M adhesives, coatings, and sealers are used in commercial trailer and mobile home production is related in Bulletin Z-TLR. Photos show several

R B&W FASTENER BRIEFS

RUSSELL, BURDSALL & WARD BOLT AND NUT COMPANY

Technical-ities

By John S. Davey

Select proper bolt diameter

An erroneous rule of thumb worth forgetting is that no bolt under ⅝" should be used where fastened members are under stress. Yet bolts ½-inch and smaller take plenty of external loading.

HOW TO LOOK AT IT

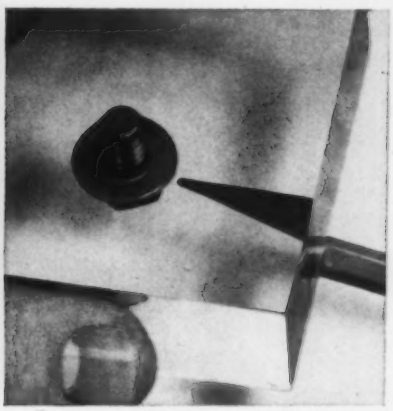
Primarily, you have to satisfy the stress requirements . . . the load. So select bolts on that same basis: the actual strength to sustain that load.

Calculating the strength requirements will tell you what bolt tensile, size, and number you need. If smaller bolts suffice, use them to avoid the penalty of overdesign. Holes can be smaller which means faster drilling and tapping. You have a chance to save materials since with smaller bolt holes, fastened members can often be made smaller too. You may also be able to standardize on a single size, saving assembly-line time.

SIZE VS. SAFETY

Remember that for a given grade of material, size tells you *capacity* of a bolt, not its *safety*. If you *tighten* a bolt to capacity, then you get safety. That's why a smaller bolt properly tightened is better and safer than a larger bolt sloppily tightened, especially where the loads are dynamic. Obviously, you reduce risk of under-torqued bolts as you reduce their size.

The new RB&W "SPIN SEAL" fasteners have spring-type washer with adhering flow-in seal . . . pre-assembled to standard machine or tapping screw.



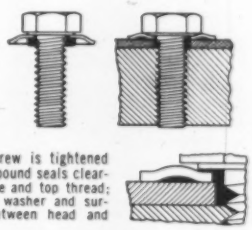
Flow-in sealant is confined by washer. Note how seal fills space under head and flows around and into threads in tightened SPIN-SEAL screw.

New SPIN-SEAL* screws give leakproof fastening

Here is a new type of composite fastener that seals by means of a unique flow-in sealant and washer.

ASSURES TRIPLE SEAL

Concave in shape, the heat treated springy washer confines and controls the flow of sealing compound. Tightening the screw forces sealant into various spaces around (1) threads, (2) head and (3) clearance hole to give hermetic sealing.



When screw is tightened the compound seals clearance hole and top thread; between washer and surface; between head and washer.

The washer has ability to conform to curved surfaces and still seal securely against hydrostatic pressures and wind driven water. Its spring tension and flat rim give the added advantage of dynamic metal to metal seal.

ONLY THE SCREW TURNS

Washer does not turn with the screw. This prevents twisting or tearing the sealing "gasket", marring of polished surfaces, or gouging of painted finishes.

The flow-in gasketing compound is plastic rather than elastic. Stable and non aging, it won't split or ozone-check under pressure. It gives controlled flow into clearance spaces. Compounds are available to seal out water or oil.

Send for Bulletin SS-1 which gives details on RB&W "SPIN-SEAL" fasteners. Russell, Burdsall & Ward Bolt and Nut Company, Port Chester, N. Y.

* T.M.

Plants at: Port Chester, N. Y.; Coraopolis, Pa.; Rock Falls, Ill.; Los Angeles, Calif. Additional sales offices at: Ardmore (Phila.), Pa.; Pittsburgh; Detroit; Chicago; Dallas; San Francisco.

Come talk over your fastener problems with the RB&W Fastener Man in Booth 986 at the Design Show in Chicago, April 14-17.

Circle 501 on Page 19

CHACE

THERMOSTATIC BIMETAL
ACTUATES ANOTHER
PRECISION PRODUCT

I-T-E

"CORDON"
CIRCUIT
BREAKER

A Product of
I-T-E Circuit Breaker Co.
Philadelphia, Pa.

The I-T-E "Cordon"® Circuit Breaker is designed to safeguard low-voltage distribution circuits against fault currents up to 100,000 rms. amperes. Through the coordination of thermal-magnetic, and current-limiting action, protection is provided against momentary overloads as well as low or high magnitude fault currents. In one compact, easily installed, easily serviced unit, "Cordon" supplies an economical solution to ever-increasing interrupting requirements.

I-T-E's high quality-standards for its "Cordon" Circuit Breaker are met by Chace Thermostatic Bimetal, a product of over a third of a century of specialization. Precision-rolled by Chace to the closest tolerances, Chace Bimetal qualifies for the job only after a relentless series of tests and inspection procedures. Chace Thermostatic Bimetal is manufactured by a series of exclusive processes which create a product acclaimed for its performance, assurance that each unit will perform its equipment-safeguarding role with instantaneous, automatic, and unfailing action at all times. It is for reasons such as these that Chace Thermostatic Bimetal is specified for actuating the widely-used, high-quality I-T-E-"Cordon" Circuit Breaker.

Remember Chace when you design for protection of valuable equipment or for temperature actuation or indication. Dependable Chace Thermostatic Bimetal is available in over 30 types, in strip, coil or completely fabricated and assembled elements made to your specification. (We do not manufacture complete controls or any other devices in competition with our customers). Write today for *new* 1958 booklet, "Successful Applications of Chace Thermostatic Bimetal," containing interesting uses of bimetal and many pages of engineering data that may help you solve your design problems.

W. M. CHACE CO.
Thermostatic Bimetal
1616 BEARD AVE., DETROIT 9, MICH.

typical applications of the products. 4 pages. Minnesota Mining & Mfg. Co., Adhesives, Coatings & Sealers Div., 423 Piquette Ave., Detroit 2, Mich. H

Circle 830 on Page 19

Tantalum Capacitors

Type HP tantalum capacitors for 125° C applications are described in illustrated Bulletin 6.111-1. Detailed application data, specifications, and ratings are included, along with performance graphs. 4 pages. Fansteel Metallurgical Corp., Rectifier-Capacitor Div., North Chicago, Ill. J

Circle 831 on Page 19

Infrared Glass

Servofrax arsenic trisulfide glass, a stable, nontoxic, noncorrosive, homogeneous glass which transmits infrared, is subject of illustrated Booklet TDS-4. Over 50 different optical flats, 25 single-element lenses, and achromat lenses are listed. Properties and specs are included. 8 pages. Servo Corp. of America, 2020 Jericho Turnpike, New Hyde Park, N. Y. D

Circle 832 on Page 19

Pyrometers

Technical data on Pyro optical, micro-optical, radiation, immersion, surface, and indicating pyrometers are included in illustrated Catalog 175. Features, principles of operation, and available accessories are covered. 8 pages. Pyrometer Instrument Co., Bergenfield, N. J. D

Circle 833 on Page 19

Special Alloys

Engineering properties and fabrication characteristics of special alloys for electronic, magnetic, and electrical applications are detailed in illustrated book. Physical constants, mechanical properties, working instructions, heat treatment, and corrosion resistance are among subjects detailed. Many graphs and tables are included. 64 pages. Carpenter Steel Co., 320 W. Bern St., Reading, Pa. C

Circle 834 on Page 19

High Density Polyethylene

Basic manufacturing techniques for using Grex high density polyethylene are described in two booklets: "Molder's Guide to Injection Molding Grex High Density Polyethylene" and "Fabricating Guide to Extruding." W. R. Grace & Co., Polymer Chemicals Div., 225 Allwood Rd., Clifton, N. J. D

Circle 835 on Page 19

Instrument Cases

Illustrated Bulletin 400G describes 120 different types and sizes of standard instrument cases. They are made of drawn aluminum with stress-loaded hardware and reinforced rims. 4 pages. TA Mfg. Corp., 4607 Alger St., Los Angeles 39, Calif. L

Circle 836 on Page 19

Aluminum Mill Products

Among aluminum mill products described in 1958 brochure are sheet, plate, foil, circles, casting alloys, pig, alloy ingot, rod, bar, wire, electrical conductor,

Circle 502 on Page 19

CHOICE OF BUILT-IN VALVES GIVES CONTROL FLEXIBILITY

SINGLE AIR CONNECTION SIMPLIFIES INSTALLATION

RUGGED CONSTRUCTION ASSURES LONG LIFE

125 BELLOWS SALES AND SERVICE FIELD ENGINEERS

■ There are one or more Bellows Field Engineers in every industrial area of the United States and Canada. They will be happy to work with you in applying "Controlled-Air-Power" to your machine designs. They are listed in their local phone directories under "The Bellows Co."

758-B

Four reasons why THE BELLOWS AIR MOTOR stands first with design engineers

In designing for air cylinder operation the engineer wants first of all sure, positive control, easily interlocked to related machine movements. **He has it in The Bellows Air Motor.**

He wants simple installation, uncomplicated by cumbersome piping. **He has it in The Bellows Air Motor.**

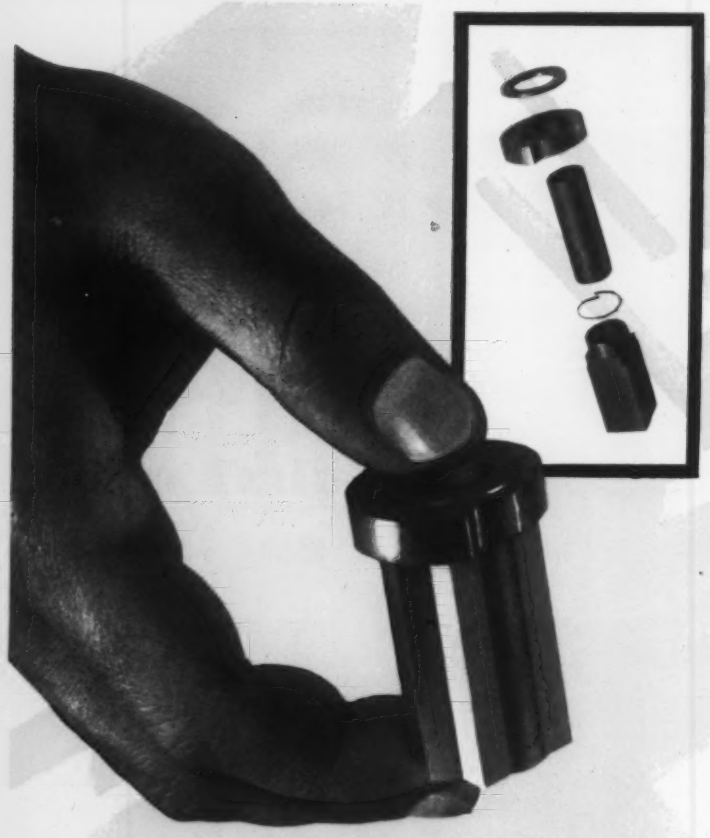
He wants rugged construction — an air cylinder that will stand up day in and day out with minimum requirements for service and repairs. **He has it in The Bellows Air Motor.**

But he also wants the knowledge, if service should ever be needed, that it is quickly available wherever his machine may go. **He has it in The Bellows Air Motor.**

The Bellows Co.

AKRON 9, OHIO

This free booklet offers interesting data for the design engineer. Write for it today. Address Dept. MD-458, Ask for Bulletin BM-25. The Bellows Co., Akron 9, Ohio. In Canada: Bellows Pneumatic Devices of Canada, Ltd.



ONE PART REPLACES FIVE!

BY POWDER METALLURGY

Tremendous savings and performance advantages resulted when Dixon Sintaloy Engineers, in collaboration with the Briggs & Stratton Corporation, redesigned this five-piece cam and ratchet as a single powder metallurgy part. Excellent bearing qualities plus self-lubrication of the Sintaloy iron-copper part eliminated the need for the bronze bearing insert and thrust washer. The cam is now integrally formed and heat treating provides the required surface hardness. Since the ratchet no longer has to be machined from stock shapes, the most efficient contour can be employed and formed right in the part. Delivered to Briggs & Stratton, ready-to-use, the Sintaloy part with inherently fine surface finish and close tolerances, minimizes inspection, eliminates further finishing, simplifies inventory, and frees production facilities for other work.

These are but some of the outstanding advantages of Sintaloy Powder Metallurgy in one particular case. It costs nothing to determine how it can also provide similar advantages for you. Write today for illustrated brochure with full design data.

DIXON SINTALOY INC.

a subsidiary of The Joseph Dixon Crucible Company
535 Hope Street, Stamford, Connecticut

forgings, extrusions, and extrusion billets. Characteristics of the metal, its properties, and fabricating and finishing techniques are covered. 24 pages. Kaiser Aluminum & Chemical Sales, Inc., 919 N. Michigan Ave., Chicago 11, Ill. I

Circle 837 on Page 19

Automatic Controls

Mercoid automatic controls for pressure, temperature, liquid level, and mechanical movement are described in illustrated Catalog 858. Data on relays and both magnetic and tilting type mercury switches are also presented. 60 pages. Mercoid Corp., 4201 Belmont Ave., Chicago 41, Ill. J

Circle 838 on Page 19

Sectional V-Belts

Sectional, adjustable length V-belts, designed for quick installation on V-drives of any length, are described and illustrated in booklet. Dixlink is made in oil, heat, and fire resistant grades, plus regular grade for general use. Use is in ½ to 1000-hp drives. 6 pages. R. & J. Dick Co., Box 388, Passaic, N. J. D

Circle 839 on Page 19

Steel Tubular Products

Information on tubing, pipe, and welding fittings for use in the process industries is contained in illustrated Booklet TB-417. Application data, selection information, analyses, physical and mechanical properties, and cost saving case histories are presented. 16 pages. Babcock & Wilcox Co., Tubular Products Div., Beaver Falls, Pa. G

Circle 840 on Page 19

Centrifugal Castings

Cast and machined-to-order centrifugal castings are detailed in three illustrated bulletins. No. 150 covers nonferrous centrifugal castings. No. 152 dwells on Meehanite metal, Ni-Resist and special iron alloy castings. No. 154 describes the comparative specifications, chemical analyses, and physical properties of nonferrous castings. 6, 6, and 4 pages. Shenango Furnace Co., Centrifugally Cast Products Div., Dover, Ohio. G

Circle 841 on Page 19

Stationary Tachometers

Mechanical centrifugal Model J stationary tachometers for permanent mounting on machines are illustrated in descriptive Bulletin 795. Dial size is 4 in. They can show rpm's, fpm, miles, gallons, or other measurements in a wide variety of ranges. 4 pages. Herman H. Sticht Co., 27 Park Place, New York 7, N. Y. C

Circle 842 on Page 19

Push-Pull Controls

Series D1100 hand-operated Tru-Lay push-pull controls for light load applications up to 30 lb are subject of folder DH-72 A. Controls are used for power take-off and choke or throttle installations on trucks, maintenance vehicles, and materials handling machinery. 4 pages. American Chain & Cable Co., Automotive

Circle 504 on Page 19

To every user of threaded fasteners:

New SPS Thread Metrology Labs will help you

- **Analyze and eliminate thread fit problems**
- **Establish more reliable gaging techniques**
- **Check and set inspection gages accurately**

As part of a continuing program to help threaded fastener users meet today's demand for increased product reliability, SPS has just opened new Screw Thread Metrology Laboratories at three key points across the country. The three identical facilities make available to you the advanced gaging techniques, precision measuring machines, and screw thread technology employed by SPS itself. These laboratories are located at:

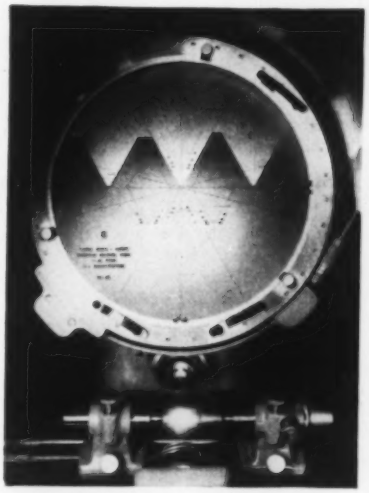
Jenkintown, Pa.—Just north of Philadelphia, SPS headquarters plant, Highland Ave.
Phone: TUrner 4-7300

Cleveland, Ohio—At the plant of Cleveland Cap Screw Co., an SPS Company, 4444 Lee Rd.
Phone: LUdlow 1-3000

Santa Ana, Calif.—SPS Western 2701 S. Harbor Blvd.
Phone: KImberly 5-9311

Basic services of the new SPS Metrology Labs include analysis of fastener fit problems; checking and setting of screw thread inspection gages with highly accurate equipment; and setting up of reliable thread inspection methods in conformance with recognized standards. In addition, these new SPS facilities will serve as a clearing house for the latest information on threaded fasteners.

ELECTROMECHANICAL LEAD TESTER. Checks from 4 to 80 threads per in.; lengths to 4 in.; diameters to 8 in. Precision: .00001 in.



OPTICAL COMPARATOR. Standard equipment at each SPS Metrology Lab. Permits magnification of screw thread profiles from 10x to 100x on 14 in. viewing screen. Precision: .0001 in.

Each laboratory—a showplace of modern measuring equipment—is temperature and humidity controlled to insure the reliability of its instrumentation. Each has complete equipment for precision measurements of all screw thread elements—major, minor and pitch diameters, half-angles, lead, radii, etc.; for gage setting; and for inspecting thread forming tools themselves if necessary. Equipment at each location includes electromechanical measuring machines for determining thread dimensions to the nearest one hundred-thousandth (.00001) inch; primary reference standards, of even greater precision, for calibrating these machines; optical comparators for studying screw thread profiles enlarged 100 times; and profilometers that measure surface smoothness as close as one millionth inch. This and all the other equipment will be devoted especially to measurement and inspection of the following classes and types of thread:

Unified Screw Threads—Class 3A, 2A, 3B, 2B; National Standard Screw Threads—Class 3, 2; Tapered Threads—ANPT, NPTF types. (Special thread types or forms can also be measured or inspected with the facilities of these laboratories.)

SPS believes that the services rendered by the new laboratories will help fastener users set up or augment their own thread size control systems to eliminate misfits that might cause delays on the assembly line or compromise the reliability of finished products.

Fastener users are invited to put these laboratories to their service any time. Simply contact your SPS salesman or distributor or get in touch with the lab nearest you. And remember, whether you have any immediate fastener problem or not, a visit from you will be welcomed. Write for free booklet describing the laboratories in detail. STANDARD PRESSED STEEL CO., Jenkintown 18, Pa.

hiRf
High Reliability factor

At SPS we apply a dynamic standard of quality—continually refined—so that our fasteners will always have the high reliability factor required by today's faster speeds, higher temperatures, and greater dynamic forces. By using SPS fasteners in your assemblies, you increase overall reliability—the certainty of predictable performance under actual service conditions.

For more information on the full meaning of reliability, write for a copy of the new SPS booklet "Concerning High Reliability."

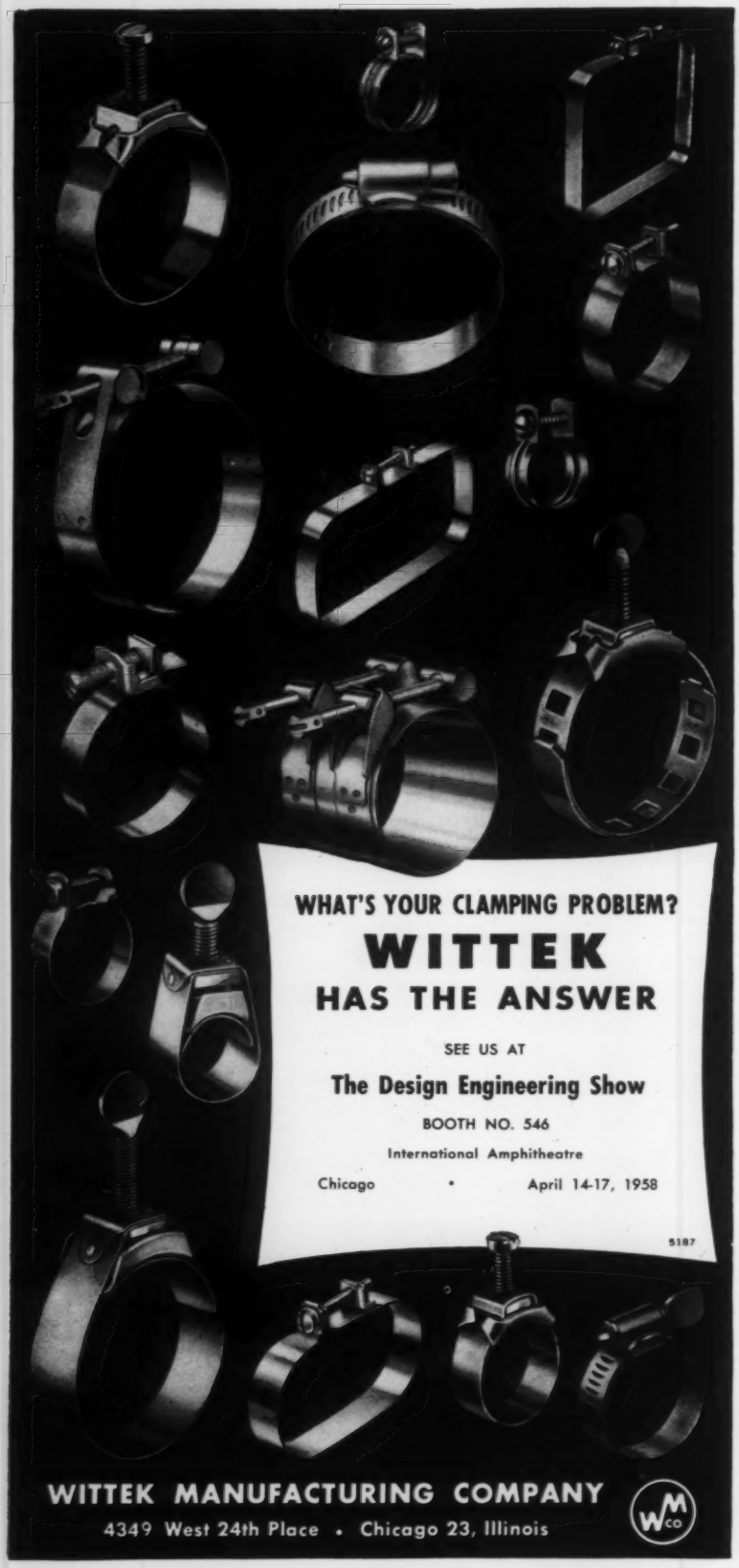
We also manufacture precision titanium fasteners / write for free booklet

See us at the ASTE Show— May 1-8, Booth 322

SPS **Jenkintown • Pennsylvania**

Standard Pressed Steel Co. • The Cleveland Cap Screw Co. • Columbia Steel Equipment Co. • National Machine Products Co. • Nutt-Shel Co. • SPS Western • Standco Canada Ltd. • Unbrako Socket Screw Co., Ltd.

Circle 505 on Page 19



& Aircraft Div., 601 Stephenson Bldg., Detroit 2, Mich. H

Circle 843 on Page 19

Variable Speed Drives

Descriptive Bulletin AP-158 covers variable speed drives and flexible couplings for speed change requirements from fractional to 20 hp. Ratios range up to 8:1. Bases and a remote control are also described. 4 pages. Gerbing Mfg. Corp., 11800 Milwaukee Ave., Northbrook, Ill. J

Circle 844 on Page 19

High Pressure Transducers

Servonic Model H pressure transducers provide accurate measure of pressures in corrosive fluids while exposed to extreme environmental conditions. These units are subject of Technical Bulletin SI-581. Servonic Instruments, Inc., 640 Terminal Way, Costa Mesa, Calif. L

Circle 845 on Page 19

Platinum-Clad Metals

An alternative material for solid platinum-group metals, PLA-5 platinum-clad metals save metal, improve mechanical strength and electrical conductivity, and hardness or wear qualities. Technical Data Bulletin PLA-5 describes single overlay, double clad, edgelay, top-lay and inlay types. 2 pages. Metal & Controls Corp., General Plate Div., Attleboro, Mass. B

Circle 846 on Page 19

Load Instruments

Precise measurement of pressure, force, tension, and weight with load cells is function of electronic Speedomax G indicators and recorders. Specifications are given in illustrated Folder ND46-20(1) for compression and tension type load cells and the load cell indicators and recorders. 4 pages. Leeds & Northrup Co., 4934 Stenton Ave., Philadelphia 44, Pa. E

Circle 847 on Page 19

Self-Priming Pump

Air or liquid alone, or any combination of air and liquid can be handled by the self-priming liquid ring pump, described in Bulletin 725.6 for permanent or portable transfer or similar uses. Performance curves and specifications are given. 4 pages. Goulds Pumps, Inc., 41 Black Brook Rd., Seneca Falls, N. Y. D

Circle 848 on Page 19

Timing Devices

Engineering data relative to Synchron timing motors, clock movements, and direct-current motors are provided in folder 5a/Ha. Units are used in timing machines, air conditioning controls, turntables, motion displays, special controls, radio control mechanisms, and aircraft instruments. 4 pages. Hansen Mfg. Co., Princeton 10, Ind. J

Circle 849 on Page 19

Hydraulic Cylinders

Line of 2000-psi, double-acting hydraulic cylinders described in Bulletin 71000 is offered for foot lug, center lug, front

Circle 506 on Page 19

Save 27% or more in cost...

NEW

Miller

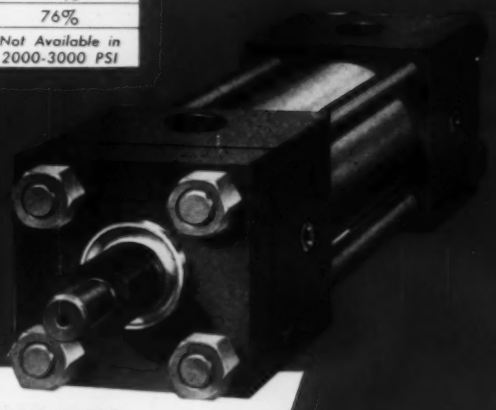
"JOB RATED"

HYDRAULIC CYLINDER LINE

JOB RATED, MODEL " J "

BORE	SEVERE OPERATING CONDITIONS	MODERATE OPERATING CONDITIONS	YOU SAVE THIS % IN PRICE OVER STANDARD 2000-3000 PSI CYLINDERS
1½"	1500 PSI	2500 PSI	27%
2	1500	2500	27%
2½	1000	1500	28%
3¼	1500	2500	32%
4	1000	1500	35%
5	800	1200	37%
6	800	1200	43%
8	500	800	50%
10	500	800	71%
12	500	800	76%
14	500	800	*Not Available in 2000-3000 PSI*

with IDENTICAL seals, design, and safety factors as the famous Miller "Power-Packed" Model "H" Line for 3000-5000 psi service.



SEAL FAILURE MEANS CYLINDER FAILURE!

1. *No seal made of synthetic rubber is compatible with even 50% of available, commercial, petroleum base hydraulic fluids.*

MILLER Uses All Teflon* Seals to Eliminate External Oil Leakage because Teflon is impervious to all known hydraulic fluids, even fire-resistant types.

TEFLON SHEF SEAL At Tubing Ends

No blind assembly. Is
Shear-proof
Heat-proof
Extrusion-proof
Fluid-proof

TEFLON Seals On Piston Rod And Bushing

Teflon rod flange seal requires no adjustment. Teflon bushing seal is shearproof. Teflon wiper keeps dirt out.

TEFLON Seals On Ball Check And Adjusting Screw

Non-protruding, self-locking, cushion adjusting screw interchangeable with ball check for easy access.

MILLER Uses Resin-Impregnated Leather Piston Cup Seals because they are compatible with petroleum base fluids and some fire-resistant types. Teflon cups available at small extra cost.

2. *Nicked or scored piston rods cause seal failure*

MILLER Uses Case-Hardened Chrome-Plated Piston Rods because they prevent nicks, scoring and rust.

Visit Our
BOOTH #839,
Design Engineering Show, April 16-17, Chicago Auditorium
and
BOOTH #1625
A. S. T. E. Show, Philadelphia, May 1-5

MOVE . . . You can save MORE with quality Miller "Job-Rated" Cylinders than with cut-price, lesser quality hydraulic cylinders. And the "Job-Rated" Cylinders are also available under the same immediate shipment program as the Power-Packed Line (2 hours if necessary—3 days normal).

S SHEAR PROOF
H HEAT PROOF
E EXTRUSION PROOF
F FLUID PROOF
SEAL
Teflon Pressure Energized
Hydraulic Cylinder Tubing End Seal
PAT. APPLIED FOR

OTHER MILLER QUALITY FEATURES

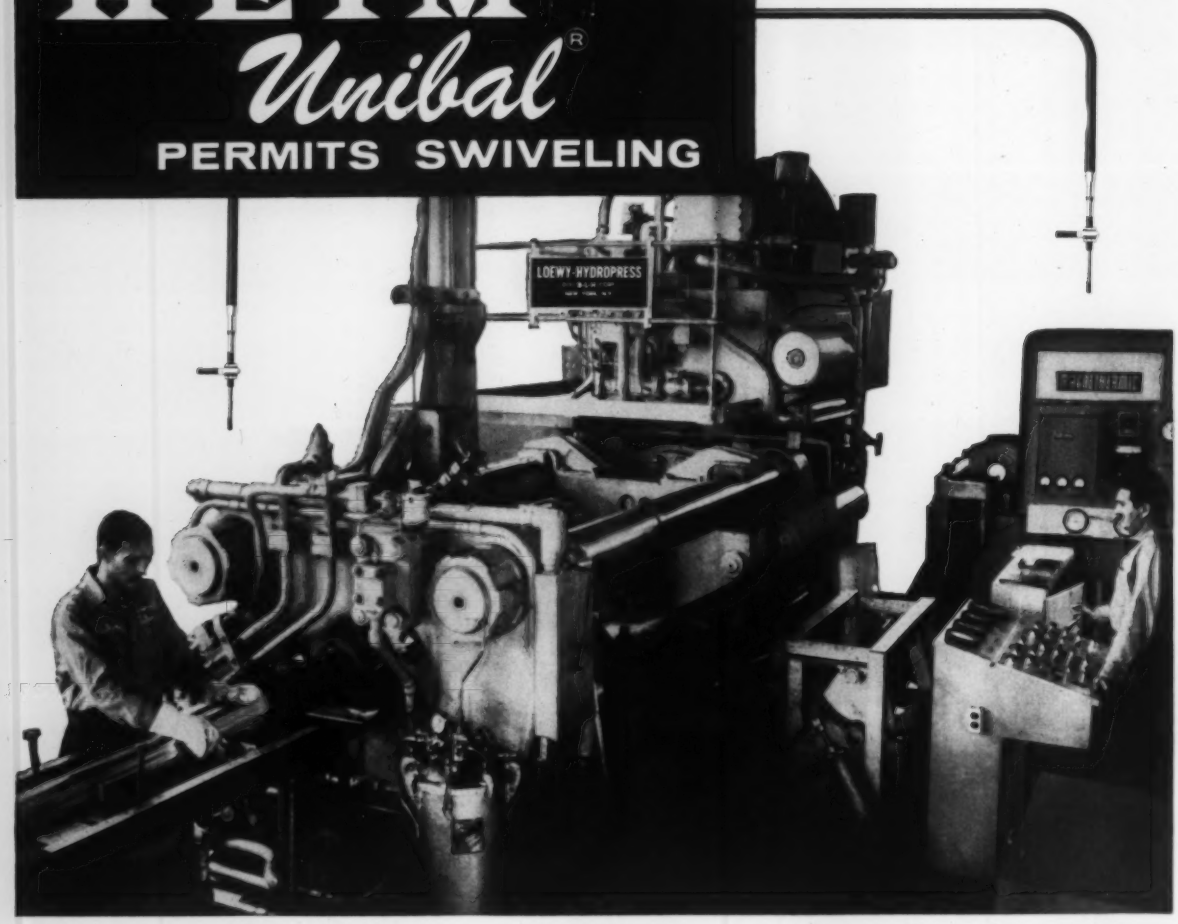
- Rust-Resistant Surfaces
- Interchangeable, Space-Saving Square, 4-Tie-Rod Design
- Precision Honed Barrels

Circle 507 on Page 19

MILLER FLUID POWER
DIVISION OF TUCK-REEDY CORPORATION
2006 N. Hawthorne Ave. Melrose Park, Ill.

AIR AND HYDRAULIC CYLINDERS • ACCUMULATORS
COUNTERBALANCE CYLINDERS • BOOSTERS

HEIM *Unibal*®
PERMITS SWIVELING



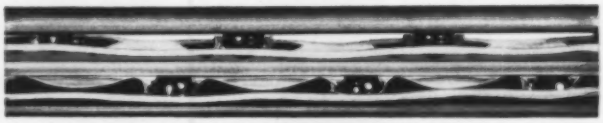
From the pulpit directly to this 1250-ton extrusion press is an ingenious, mechanical, remote push-pull control to which this giant responds. It consists of a solid, flexible stainless steel blade, 24 feet long, moving between rows of stainless steel balls and housed in a flexible tubing. It is called Controlex and is made by Controlex Corp., White Plains, N.Y.

A manually operated lever at the control board, or pulpit, moves the blade in the desired direction, and in order to permit swiveling and for the relief of eccentric thrust on the push-pull end rod, a

HEIM *Unibal*® SPHERICAL BEARING ROD END

is used at the mounting point.

Another Unibal Rod End bearing, mounted at the machine end of the control, completes the swiveling or misaligning action as required.



Controlex makes controls over 100 feet long
— a linear ball bearing with 42 balls to the foot.
Press for extruding aluminum strip, built by
Loewy-Hydropress Division of Baldwin-Lima-Hamilton Corp.

This application of the Heim Unibal demonstrates one way in which it serves as a mounting device through which the Controlex end fitting passes. Does it give you any ideas for use on *your* equipment? There seems to be an unending list of possible applications for the Heim Unibal, and our engineering department is ready to help you work out details.

Send for complete Heim bearing catalog

Sold through the leading bearing distributors.

THE HEIM COMPANY FAIRFIELD, CONN.

Circle 508 on Page 19

flange, rear flange, and clevis mounting. Specifications are tabulated. 8 pages. Oilgear Co., 1570Q W. Pierce St., Milwaukee 4, Wis. K

Circle 850 on Page 19

Synchronous Induction Motor

Uses for the Syncro-Spede synchronous induction motor shown in Bulletin 1900 include high frequency drives, precise timing, metering and recording devices, conveyor drives, high speed applications, and adjustable frequency multi-motor systems. Ratings range from 1 to 100 hp. 8 pages. Louis Allis Co., 427 E. Stewart St., Milwaukee 1, Wis. K

Circle 851 on Page 19

General Purpose Controls

Line of general purpose controls covered in Catalog GEC-1260C includes motor starters, contactors, relays, solenoids, limit switches, pushbuttons, and pilot devices. Charts aid in selection of proper starter up to 200 hp, heater, and push-button station. 88 pages. General Electric Co., General Purpose Control Dept., Bloomington, Ill. C

Circle 852 on Page 19

Snap-Action Switch

The 5200 Series miniature snap-action switch is designed for accuracy, repeatability, and long life in military and industrial applications. Switch is rated 10 amp resistive, 5 amp inductive. Single sheet Bulletin 5200-1 describes this switch. Haydon Switch Inc., Waterbury 20, Conn. B

Circle 853 on Page 19

Flexible Couplings

Distinctive advantages of Thomas all-metal flexible couplings are pointed up in condensed Engineering Catalog 51-A. Dimensions, horsepower, and speed data are tabulated. Couplings are offered in ½ to 40,000-hp ratings at 1 to 30,000 rpm. 32 pages. Thomas Flexible Coupling Co., Warren, Pa. F

Circle 854 on Page 19

Air Motors

"The Bellows Air Motor in Original Equipment Design" is title of brochure which tells how the Bellows air motor operates and covers optional mountings, alternate integral valving, and optional hydraulic control. Many original equipment installations are pictured. Air motors have strokes of 1 to 18 in. 14 pages. Bellows Co., 230 W. Market St., Akron, Ohio. F

Circle 855 on Page 19

Extruded Plastics

The 1958 edition of "Extruded Plastics" contains the latest information on complex shapes, rods, tubes, and moldings produced by this company by extrusion. Components which simulate the appearance of polished brass, chrome, copper, or gold are described. Available only by writing on company letterhead to Anchor Plastics Co., 36-36 36th St., Long Island City 6, N. Y. D

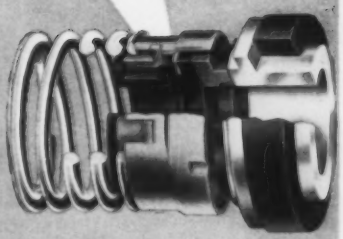
YOU insure
RUGGED FIELD PERFORMANCE
plus PRODUCTION SAVINGS

when you specify these
JOHN CRANE MECHANICAL SEALS

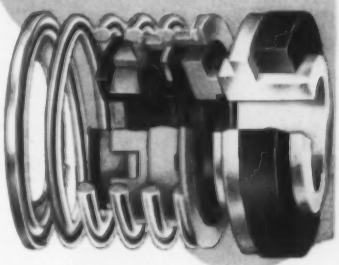
"JOHN CRANE" Types 1 and 2 shaft seals come pre-assembled. They are quickly and easily installed. Tolerances need not be critical due to the self-adjusting seal head. This is accomplished through special construction of the synthetic rubber bellows head. Moving freely under spring and hydraulic pressure, it automatically compensates for shaft end play, as well as washer wear.

Sealing faces are precision-lapped to prevent stuffing box leakage. No break-in runs necessary. Positive drive feature eliminates all stress on bellows. This feature also permits the use of light spring load to minimize wear on sealing faces. Seal needs no attention over long periods of operation.

Recommended for water, oil and other services non-injurious to synthetic rubber. Pressures to 200 psi. Temperatures: -40° to +212°F.



Type 1. For stuffing boxes of limited diameter.



Type 2. For stuffing boxes of limited length.

VISIT US AT THE DESIGN SHOW BOOTH 555
Crane Packing Co., 6425 Oakton St., Morton Grove, Ill., (Chicago Suburb)
In Canada: Crane Packing Co., Ltd., Hamilton, Ont.

CRANE PACKING COMPANY

Circle 509 on Page 19

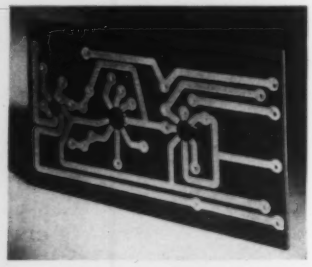
New Parts and Materials

Use Yellow Card, page 19, to obtain more information

Printed-Circuit Boards

operate at 250 C
without sagging or warping

Copper - metallized printed - circuit boards are of Fotoceram, a chemically machinable glass with flexural strength of 25,000 psi. They are designed for missiles, communication systems, control and measuring instruments, radar, and other high-reliability units. Units operate continuously at 250 C without sagging or warping, even in adverse



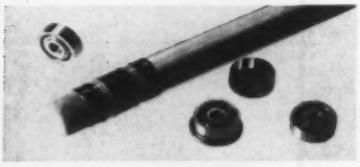
environmental conditions. The 1/8-in. copper runs and through-hole plating of boards show no indication of blisters, lifting, or metal failure. High base-to-metal strength permits repeated soldering of components without damaging copper runs. **Corning Glass Works**, Corning, N. Y. D

Circle 856 on Page 19

Miniature Ball Bearings

of vacuum-melt
440-C stainless steel

New line of miniature bearings is intended for use in sensitive control instruments, missiles, and computer elements. Bearings are made entirely of vacuum-melt 440-C stainless steel. Each bearing size has its own retainer made to ARGC-5 tolerances or better, and retainers are not interchangeable. Seven basic sizes and four designs of each size are included in the



line. Sizes range from 3/32-in. bore and 5/16-in. OD to 1/4-in. bore and 3/8-in. OD. Basic types are open, flanged, two shields, and flanged two shields. **Fafnir Bearing Co.**, New Britain, Conn. B

Circle 857 on Page 19

Polyester Laminating Film

adheres to a variety
of end products

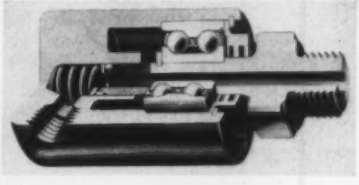
Videne A polyester laminating film adheres under heat and pressure to a variety of end products. It is for direct or stretch-laminating applications in the textile, metal, wood, paper, plastic, automotive, and packaging fields. Material has high abrasion resistance, resists outdoor aging, has excellent adhesive, electrical, and forming properties, and can be embossed or printed. It is furnished in clear and satin film finishes in gages from 2 to 7 1/2 mils. **Goodyear Tire and Rubber Co.**, Akron, Ohio. F

Circle 858 on Page 19

Rotary Joints

are permanently lubricated

B2 and C2 Rotorseals transmit air, liquids, or gases from stationary sources to rotating shafts. They feature permanent lubrication and



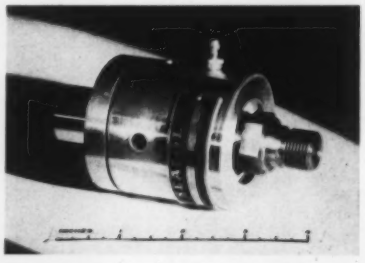
sealed ball bearings. Seal shaft is applied directly to a tapped hole in shaft of machine, and rotates on sealed ball bearings within housing. Entire unit is connected to pressure source by flexible hose. Positive protection against pressure leakage is provided by a nonmetallic sealing ring held against Rotorseal shaft by spring pressure. Units are applicable to all types of single-passage applications at pressures to 150 psi. B2 model operates at speeds to 4000 rpm, C2 model at speeds to 3000 rpm. **Airflex Div., Fawick Corp.**, 9919 Clinton Rd., Cleveland 11, Ohio. F

Circle 859 on Page 19

Fluid-Transfer Unit

operates at speeds
to 10,000 rpm

EL high-pressure fluid-transfer unit withstands continuously pulsating pressures from zero to maximum. It



operates at speeds to 10,000 rpm and pressures to 1000 psi. Applications include use in gun drills, clutches, and power cylinders. **Sealol Corp.**, Warwick Industrial Park, Providence, R. I. B

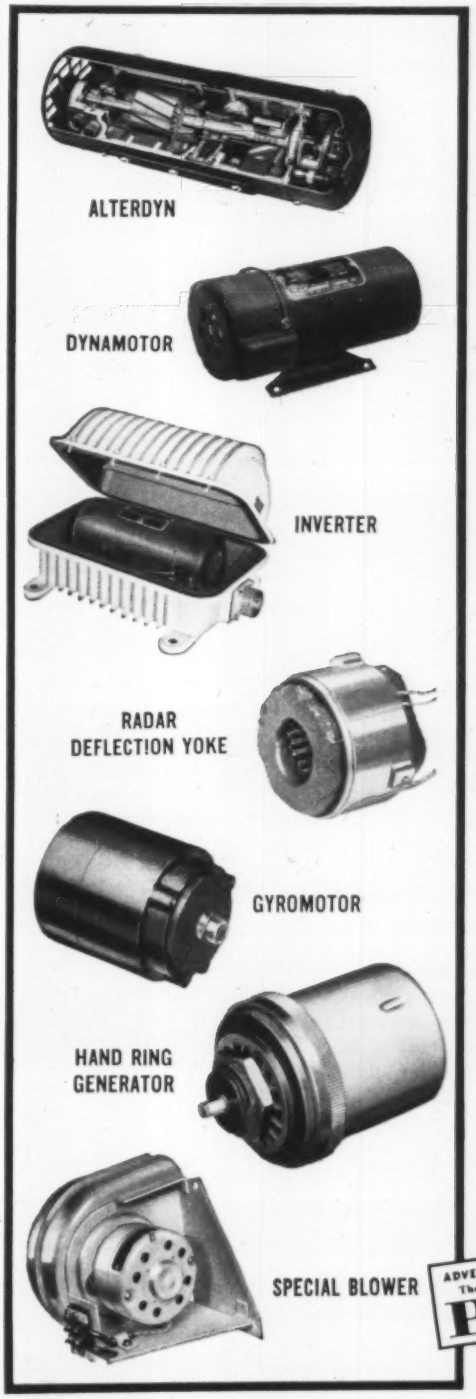
Circle 860 on Page 19

Self-Sealing Fastener

is reusable without
loss of sealing power

New self-sealing fastener incorporates a thin shim of Teflon, set in

Call on *Redmond* to Design, Develop, and Produce Rotating Electrical Mechanisms

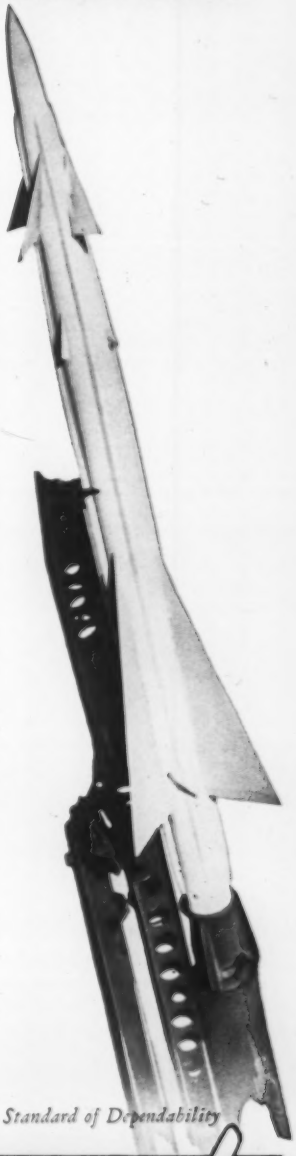


Whether your needs are for military or civilian specifications, Redmond has the development, testing, inspection, and packaging facilities to meet them.

Through the years Redmond has developed many mechanisms in the fractional horsepower field. Some of the products that either are being or have been produced in volume by Redmond are illustrated at the left. In the alterdyn, Redmond combined the dynamotor and inverter in one package. In dynamotor development, Redmond has reduced weight and frame size to a minimum. Other products are 400 cycle motors and actuator motors.

As the leading manufacturer of fractional horsepower electric motors, the Redmond Company is in a position to design, develop, and produce rotating electrical equipment. At the same time, the standard line of Redmond products can frequently be modified to meet performance and specification requirements.

Telephone, write, or wire Redmond Co., Inc., Special Products Division, Owosso, Michigan, and your problems will be given our immediate attention.



The Standard of Dependability

Redmond

COMPANY, INC.

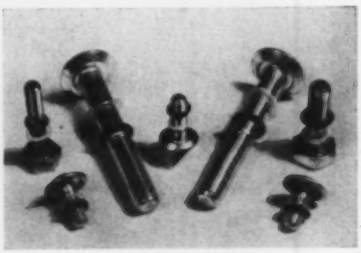
OWOSSO, MICHIGAN

ADVERTISED IN The Saturday Evening POST

REDMOND

THE **BIG** NAME IN SMALL MOTORS

Circle 510 on Page 19



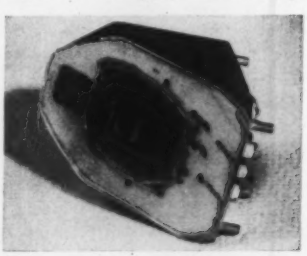
an O-ring groove in the completely cold-headed stress fastener. Shim absorbs maximum amount of friction between metal and O-ring, preventing cold flow and abrasion. Fastener can be adapted for use wherever positive no-leakage is required, in a wide range of temperatures, and in contact with most known gases and fluids. It is reusable without loss of sealing power. Design can be used in a wide variety of configurations and materials. **Uniseal Co. of California,** 8021 S. Western Ave., Los Angeles 47, Calif. L

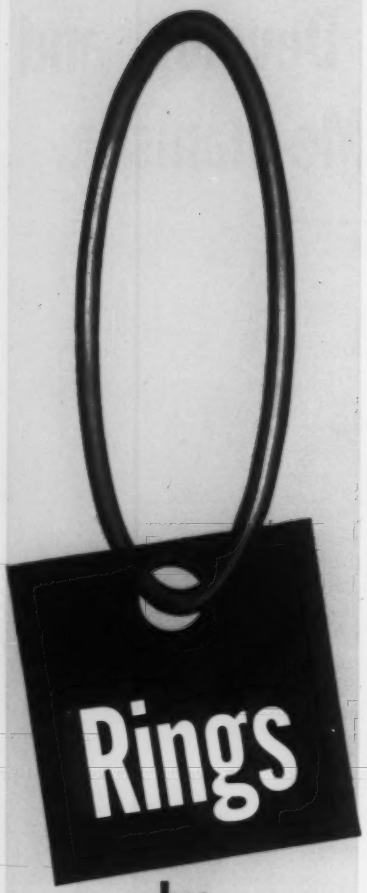
Circle 861 on Page 19

Potting Compounds

low-density plastics protect electronic components

Two new foam-in-place potting compounds for the electronics industry have particular application for missiles components. The low-density plastic materials are available in two forms. Sealfoam 601 is a two-component liquid which, when mixed and heated, expands and cures to rigid, closed-cell structure with excellent electrical characteristics and mechanical strength. It protects delicate components from moisture, fungus, vibration, and shock loading. Picture illustrates use of this material in a small transformer. Sealfoam 603 is a single-component, free-flowing powdered material which requires the low foaming temperature of 175 F. Cured material has compressive strength of 110 psi, maintains good





by

LINEAR

in low-compression-set Butyl . . . for sealing problems involving the non-flammable phosphate esters.

LINEAR . . . specialists in close tolerance molding in all of today's elastomers.

Call on LINEAR for assistance with all your seal problems.

PERFECTION IN RUBBER

LINEAR

LINEAR, Inc., STATE ROAD & LEVICK ST., PHILA 35, PA

Circle 511 on Page 19

GUARANTEED GREATER ACCURACY

than any other Variable Speed Drive

DES. ENG. SHOW BOOTH 449

ONLY Graham

most reliable variable speed drive made

offers these . . .

BIG FOUR FEATURES!

1 UNLIMITED SPEED RANGE — from any desired maximum speed to zero, including reverse, without stopping motor.

2 UNMATCHED ACCURACY — of speed setting and re-setting, and of speed holding.

3 ULTIMATE in SIMPLICITY and COMPACTNESS — a straight line extension of a standard induction motor — or available without motor.

4 AUTOMATED SPEED CONTROL — control tension, proportion, synchronization, etc. from any control signal; 3 to 15 PSI, .5 to 5 ma, potentiometer, frequency, or binary signal from punch cards, tapes, or computers.

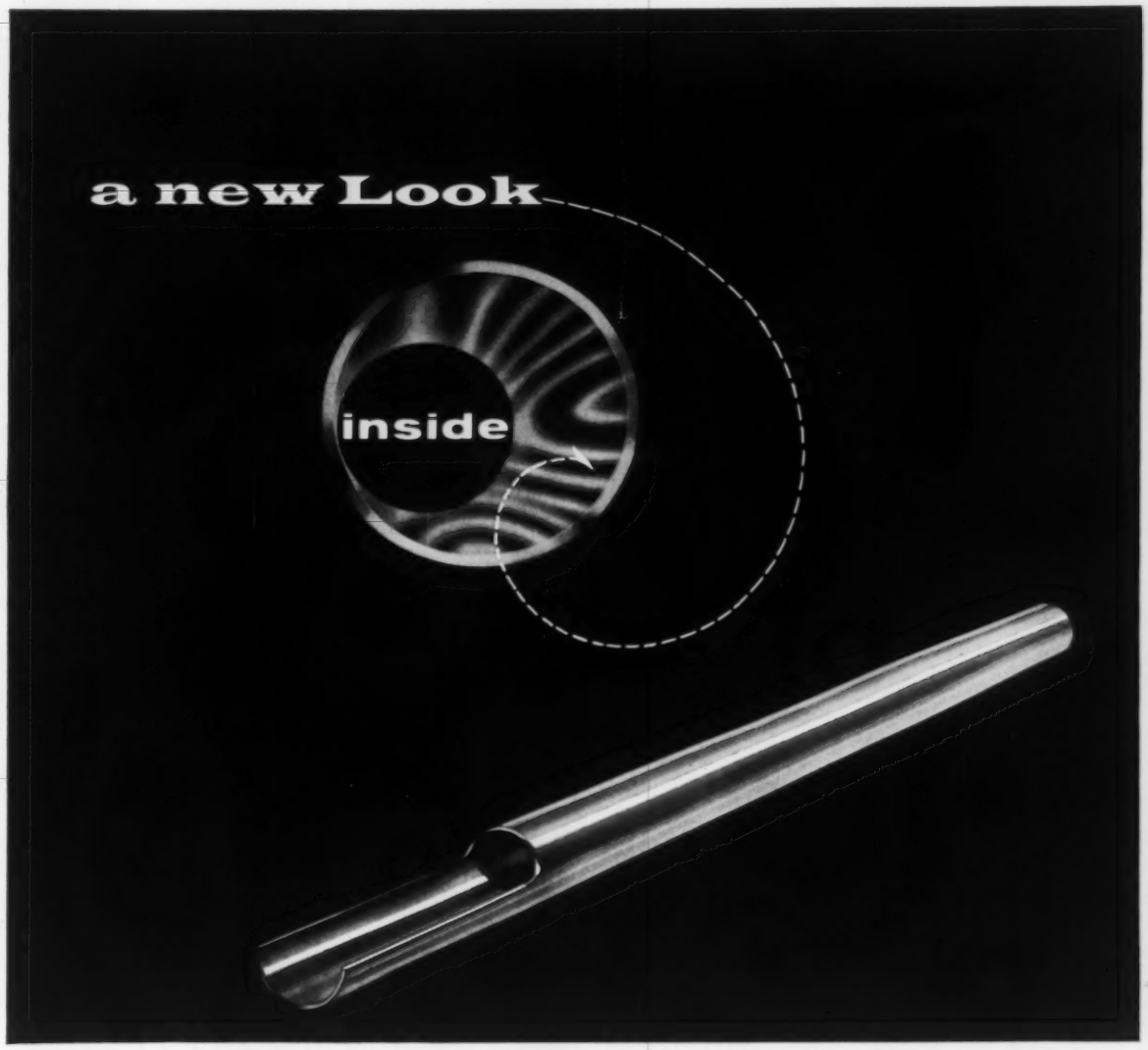
SEE OUR CATALOG IN SWEET'S PRODUCT DESIGN FILE OR WRITE FOR COPY

All this backed by PROVED PERFORMANCE to do a better job for LESS MONEY!

GRAHAM TRANSMISSIONS, INC.

DEPT. MD, MENOMONEE FALLS, WIS

Circle 512 on Page 19



LUSTRALOY—the first and only standard production stainless tube with a premium I. D. finish

Look down a Lustraloy tube and you'll say, "Premium finish"!
And you're right, based on all past standards. But this is Lustraloy
with a *production* finish . . . *selling at standard stainless tube prices.*
Lustraloy is mandrel-drawn to cold work both inside and outside tube surfaces;
finished by bright annealing. The result is tubing with uniform roundness,
consistent wall thicknesses, mirror finishes and the finest flow characteristics.
If you require seamless, stainless tubing (⅜" to ¼" O.D.)
with emphasis on I.D. finish, Lustraloy is important to you.
The attached coupon will return samples and technical information.

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STAINLESS TUBE DIVISION
COLUMBIA STEEL & SHAFTING CO.
Pittsburgh 30, Pa.

Summerill Stainless Tube Division, Dept. MD-2
Columbia Steel and Shafting Co., Pittsburgh 30, Pa.
Please send sample and technical information on LUSTRALOY.

Name_____
Co._____ Title_____
Street_____
City_____ State_____

Circle 513 on Page 19

NATIONAL OIL SEAL LOGBOOK

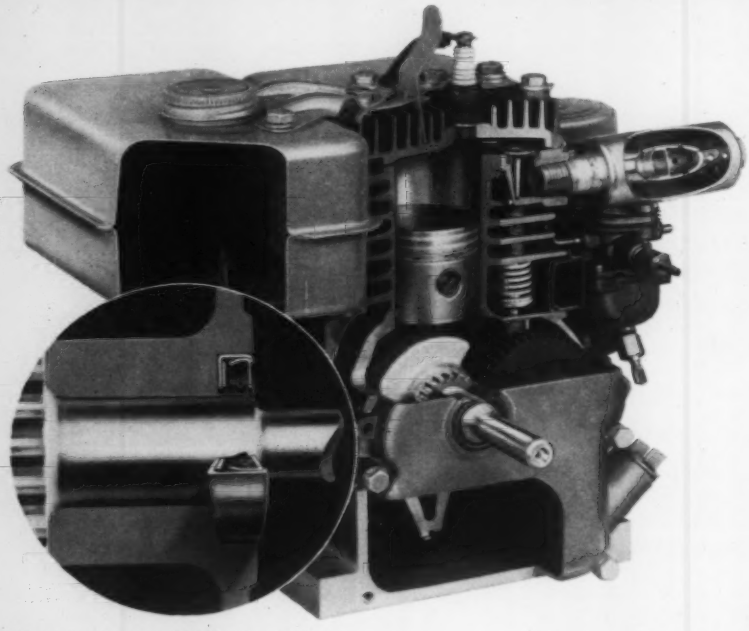


Figure 1. National 50,000-S Syntech Seal

Zero leakage oil sealing a "must" in Briggs & Stratton 2¾ hp engine

Some oil sealing applications can accept a small amount of lubricant leakage or "seepage." But not the Briggs & Stratton 8B Engine. Here, on a ⅞" crankshaft turning up to 3,600 RPM, light engine oil must be positively sealed in the crankcase at both front and rear bearing points. Oil temperature is 200° F with the engine at wide open throttle; and external temperatures may range from —30° to 125° F. Many Briggs & Stratton 8B engines operate only after long periods of inactivity; others are used continuously, a variable which makes the sealing problem even more demanding.

Satisfactory sealing and long, trouble-free service life is obtained by use of two special National Syntech® synthetic rubber seals (Fig. 1)—one at either sealing point. These precision made Syntechs have a minimum-contact sealing lip seating lightly but firmly on the shaft. The steel outer case is a precise press-fit for the bore, simplifying installation and preventing accidental working free of the seal.

National pioneered Syntech synthetic rubber seals; today offers a complete line of Syntech and leather seals plus convenient, competent oil seal engineering assistance. For data, for practical design help, call the National Seal engineer. He's under Oil Seals, in the Yellow Pages.

Variations on basic oil seal designs

10,000-S

Figure 1 shows the basic National spring-loaded Syntech oil seal design. Many modifications are also offered. For example, where external conditions require a felt dust baffle, National 10,000-S may be employed. Where dirt or grit conditions are severe, a National 20,000-S with leather or Syntech auxiliary sealing lip is often used.

230,000-S

For applications where shaft entry is made from the auxiliary side, a National 230,000-S seal with auxiliary leather washer-type sealing lip mounted *in tandem* is suggested.

70,000-S

For positive separation of low viscosity fluids at higher speeds and temperatures, National 70,000-S series seals are suggested. Basically two 50,000-S seals mounted with sealing lips opposed, this seal may be used at temperatures above 250° F and speeds in excess of 2,000 FPM.

Altogether, National offers over 2,500 basic types and sizes. There is one best seal for a given application. Your National engineer can help you obtain it.

NATIONAL SEAL

Division, Federal-Mogul-Bower Bearings, Inc.
General Offices: Redwood City, California;
Plants: Van Wert, Ohio, Downey and Redwood City, California

4628

Circle 514 on Page 19

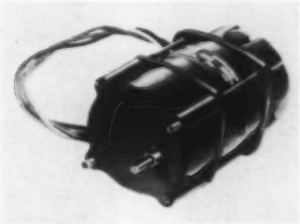
electrical resistivity even at 350 F, and is an excellent thermal insulator. **Plastics Laboratory, Minneapolis-Honeywell Regulator Co.**, 2753 4th Ave. S., Minneapolis 8, Minn. J

Circle 862 on Page 19

Adjustable-Speed Motor

is subfractional-horsepower, dc unit

New adjustable-speed, subfractional-horsepower dc motor, designated RBD-25, can be physically interchanged with RBC-25 motor. It is available in two standard models: RBD-2505, with rating of 0.5 oz-in., 115 v dc, 1800 rpm, 10 w; and Model RBD-2510, rating 1.0 oz-in., 115 v dc, 1800 rpm, 15 w, as well as in voltage ranges from 24 to 115



v and speeds from 900 to 3600 rpm. Since unit is shunt-wound dc type, adjustable-speed drive can be obtained by varying armature voltage. Motor is offered with gear reductions in ratios from 3:1 to 3600:1. **Holtzer-Cabot Motor Div., National Pneumatic Co. Inc.**, 125 Amory St., Boston, Mass. B

Circle 863 on Page 19

Stock Parts and Connectors

for building printed-circuit assemblies

Gornet structural parts and Gornector receptacles are used to build printed-circuit assemblies. They accommodate any printed-circuit board size, thickness, number of terminations, and number of boards, to form a rigid, electronic printed-circuit module. Standard guide rails are also available to facilitate printed-circuit board insertion. Receptacles are terminated in solder eyes, turrets, taper tabs, wire-wrap forms, and dip-solder lugs, with contacts joined or separated for top and bottom circuit connection or indi-

Transparent plastic cylinder head was specially constructed by Bell & Gosset Company to permit filming of valve action in portable oilless compressor.

How High Speed Movies Increased Valve Life

Bell & Gossett Company engineers in a continuing study of the performance of a new portable oilless compressor found the valve action too fast for detailed visual observation. To slow up this fast-moving action, they filmed it with a Kodak High Speed Camera at 3200 frames per second. Projecting this film at a normal 16 frames a second slowed the valve action 200 times and enabled the engineers to see exactly what was going on. They noticed that the valve flapper was cycling in excess of the action of the piston.

Repetitive study of the filmed action by the engineers resulted in a simple redesign that assured prolonged valve life—made a good compressor even better.

Perhaps you, too, face machine design problems which conventional methods cannot solve. You'll find the answers quickly and at a minimum cost of time, money, and manpower—with high speed movies.

For complete details send for free booklet, "High Speed Motion Pictures at the Service of the Engineer."

EASTMAN KODAK COMPANY, Rochester 4, N. Y.

the Kodak *HIGH SPEED* Camera

Circle 515 on Page 19

Fastener Facts

DESIGN PRODUCTION & PURCHASING DATA

by Paul Tunison, Chief Engineer — Judson L. Thomson Mfg. Co.

USE OF BIFURCATED (SPLIT) RIVETS

Self-Piercing Fasteners

You specify bifurcated (split) rivets when you want self-piercing, permanent fasteners for high-speed assembly of light metals (up to 0.040" thick), wood, fibre, leather, canvas and plastics.

Slots milled in the bodies of cold-headed solid rivets form two prongs that have the inherent strength of forgings.

Advantages of Use:

With bifurcated rivets, you not only eliminate the delay and cost of pre-punching or pre-drilling holes, but also avoid weakening assemblies through removal of material. Applied by high-speed automatic rivet-setting machines, which can be operated by unskilled help, they reduce assembly time and costs to a minimum.

When you specify Thomson Bifurcated Rivets, you make sure of the fastest possible solution to your fastening problem and earliest possible delivery of test samples and production quantities.

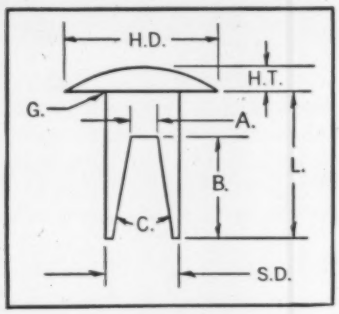
As the first patent holder on bifurcated rivets, Thomson has the longest experience in applying them. Since 1885, thousands of standards have been developed for manufacturers of canvas bags, dog collars and harnesses, golf bags and shoes, hand bags, leather goods, luggage, raincoats, sheet metal products and assemblies, sporting goods, tote boxes, and other products. So your chances of solving special problems with standard bifurcated rivets are best when you call on Thomson.

DIMENSIONAL DATA:

Head Diameter (H.D.) ranges between 1.75 and 2.75 times shank diameter for rivets produced by single-die heading machines. Larger diameters are available at higher cost.

Head Thickness (H.T.) ranges from 0.3 to 0.6 times shank diameter depending on head shape: oval, flat countersunk, ideal, flat, countersunk with bevel on bottom.

Shank Diameter (S.D.) ranges from .040" to .330" for standard sizes.

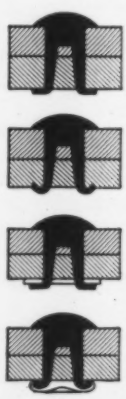


Slot Width (A.), Slot Depth (B.) and **Slot Angle (C.)** vary with each application, depending on thickness and hardness of materials and strength requirements of the clinch. Tests on actual samples are recommended in most cases.

Rivet Length (L.) ranges from 0.6 to 6 times shank diameter. Exact length is generally determined by adding shank diameter to assembly thickness.

Radius (G.) at corners ranges from .005" for ¼" rivets to .015" for 2" rivets.

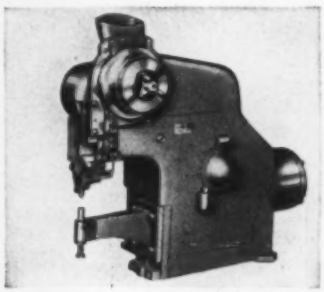
Four Types of Clinch:



Thomson Bifurcated Rivets are clinched by anvils that spread the prongs flush with the surface, turn their prongs into material, against burrs (washers) or inside caps. The latter two methods are specified when a stronger bearing surface is required. The use of caps improves assembly appearance by giving uniform appearance to both ends of the rivets. Washers and caps are applied by multiple-feed automatic rivet-setting machines. The use of caps, calls for perfectly symmetrical rivets so that neither prong will miss the cap. Thomson guards against such misses by precision manufacturing, statistical quality control, 100% final inspection and factory tests on actual samples.

High-Speed Rivet-Setting Machines

Whatever your fastening job, the chances are that one of Thomson's more than 200 standard rivet-setting machines can be quickly and easily adapted to fit your needs. Models include combination rivet and cap-setting in both bench- and floor-types with 5" throat depth. Automatic hopper feed, multiple rivet-setting heads and special work-handling and loading devices are accessories that speed up assembly. Thomson helps you select the proper machine for your job, custom-tools it to meet your requirements and factory-tests it on actual samples before shipment. Available on a sale or lease basis.



MOTOR-OPERATED BENCH MACHINE

Design and Engineering Service

Save time and money by asking Thomson Engineers to study your fastening problems before your designs are frozen. This service, performed at your request, promises the speediest delivery of the right rivets and machines for you. Send sketches, prints, or actual samples for recommendations and quotations.

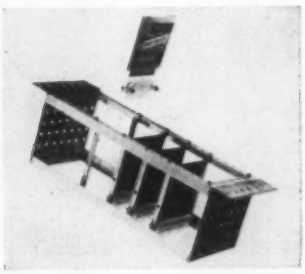
Free "Fastener Fact File".

This new Thomson manual is compulsory reading for anybody who specifies or buys fasteners. It covers everything you need to know to take advantage of the economy and speed of rivets and rivet-setting machines: rivet types, applications, material finishes and other vital factors.

Request your copy today. Write Judson L. Thomson Mfg. Co., Dept. B, Waltham 54, Massachusetts.

JUDSON L. THOMSON MFG. CO., WALTHAM 54, MASS.

See Us at Booth 308 at the Design Show



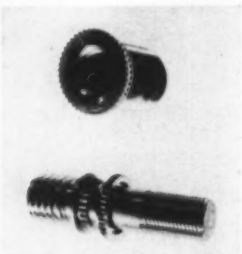
vidual face termination. Available in a variety of materials and finishes, units are suitable for many military and commercial environments. **Gorn Electric Co. Inc.**, 895 Main St., Stamford, Conn. B

Circle 864 on Page 19

Fluid Studs and Inserts

fasten high-pressure hydraulic parts

Fluid-system studs and inserts seal component and system parts against pressures to 3000 psi. Designed for hydraulic, pneumatic, and other pressurized-fluid systems, the studs and inserts are used in installations where fastener is exposed directly to pressurized areas or compartments. Applications include use in aircraft and industrial hydraulic and pneumatic equipment such as



pumps, turbines, valves, and flow regulators. Units incorporate positive locking. **Rosan Inc.**, 2901 West Coast Highway, Newport Beach, Calif. L

Circle 865 on Page 19

Vinyl Wire Marker

withstands 300-F temperature without discoloring

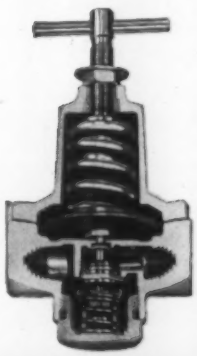
All-vinyl wire marker, 5 mils thick, is adaptable to permanent-wire identification in oily and solvent-laden atmospheres. Self-adhesive and flexible, marker clings tightly to plastic insulated wires and with-

FACTS about *Norgren* PRESSURE REGULATORS

Norgren Pressure Regulator on punch press at Shwayder Brothers, Inc., maker of Samsonite Luggage.

Reduce Air Costs... Cut Maintenance Costs

For any air operated equipment, there is one pressure at which it is designed to operate most efficiently. Above that pressure, equipment will wear excessively with no significant increase in output, and compressed air will be wasted. No matter what the application, you can choose a Norgren Pressure Regulator that will reduce line pressure to the desired working pressure. Results will include longer equipment life, lower maintenance costs, less down-time and savings in compressed air costs.



- **Norgren Pressure Regulators are Highly Accurate** over a wide operating range.
- **Regulated Pressure is Held Constant** even with widely fluctuating line pressure and rapidly varying air flow.
- **Flow Capacity is Large**—a. Balanced valve construction; b. Large effective diaphragm area; c. Improved baffle and siphon performance; d. Large passages; e. Large valve openings.
- **Choice of Relieving or Non-Relieving Regulators.**

For complete information on all your regulator needs 1/8" to 2" inclusive, call your nearby Norgren Representative listed in your telephone directory—or WRITE

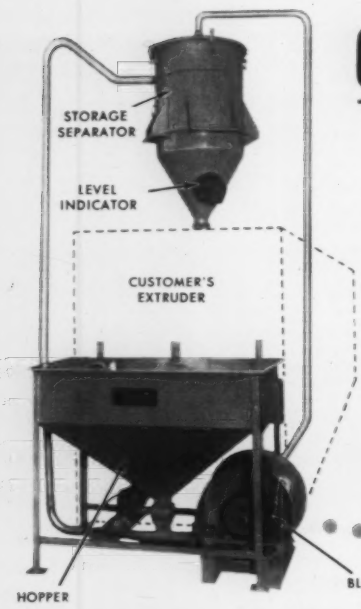
For No. 900 Catalog

C. A. NORGREN CO.

3442 SOUTH ELATI STREET ENGLEWOOD, COLORADO

Circle 517 on Page 19

Design Problem Here Was



CONTINUOUS FEEDING OF PLASTIC PELLETS

SPENCER Blowers Provided the Solution

This designer's problem was to find a means of *automatically* feeding plastic pellets into extruders—*continuously*. A *closed* system was necessary to prevent contamination of material with atmospheric dust and to prevent escape of plastic "fines".

A Spencer blower, incorporated with the customer's equipment as shown, solved the problem. Pellets in hopper are gravity fed through a rotary valve into the air stream, then conveyed up to the storage separator as required.

When level indicator registers sufficient drop in level, another quantity of pellets is fed from the bin into the extruder.

Spencer will be glad to assist in adapting standard blowers or vacuum producers—or designing special units—to meet *your* particular needs.

Two Catalogs to Aid the Designer

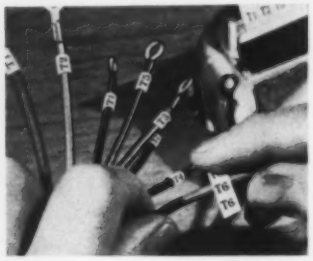
"132 UNUSUAL USES OF SPENCER VACUUM"
Bulletin 144 illustrates and describes how Spencer Vacuum is used in industries from A to Z.

"TURBO DATA BOOK"
Supplies application data on Spencer Blowers. Request Bulletin 107-C.

STANDARD CAPACITIES
of Spencer Blowers
⅓ HP to 1,000 HP
Up to 20,000 CFM
4 oz. to 10 lbs. pressure

The SPENCER TURBINE COMPANY
HARTFORD 6, CONNECTICUT

Circle 518 on Page 19



stands temperatures to 300 F without discoloration. Marker is of polyvinyl-chloride tape with black legends on white background, and is sealed in clear, high-gloss vinyl overcoating. Marker is 1½ in. long and identifies all types of wires with OD of more than ¼ in. Available also are markers ¾ in. long for identifying wires 5/32 through ¼ in. OD. **W. H. Brady Co.**, 727 W. Glendale Ave., Milwaukee 9, Wis. K

Circle 866 on Page 19

Clad Stainless Steel

electrical-contact material is silver clad

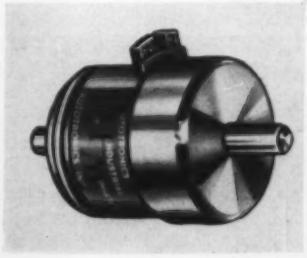
Silver-clad stainless steel is used as an efficient, inexpensive electrical contact material. It is extremely resistant to corrosive atmospheres. The material is supplied as a cladding on one or both sides of a stainless-steel base, as an inlay in the base, or as a strip on edge of base. **American Silver Co. Inc.**, 36-07 Prince St., Flushing 54, N. Y. D

Circle 867 on Page 19

Miniature Clutch

electromagnetic unit has torque of 40 oz-in.

C-125 electromagnetic clutch features small size, high performance, servo or face mounting, and zero backlash. Clutch has 1.125-in. pilot mounting diam, clutching torque of 40 oz-in., and is completely self-

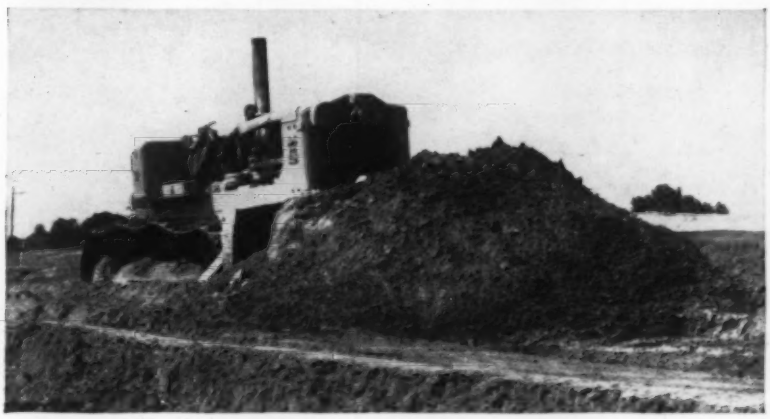


Circle 519 on Page 19→

DOW CORNING CORPORATION

Silicone News

FOR DESIGN ENGINEERS No. 49



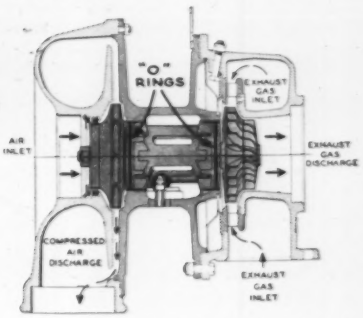
A DURABLE HOT OIL SEAL

Immunity to high temperatures or to attack by fuels, oils and solvents makes Silastic*, the Dow Corning silicone rubber, an ideal sealing and gasketing material. How these properties contributed to the reliability and maintenance-free performance of diesel tractors is related by Caterpillar Tractor Co., Peoria, Ill.

Caterpillar Tractor recently scored an industry "first" by factory-equipping its powerful D-9 heavy diesel crawler with a turbocharger. The application was developed jointly by Caterpillar and AiResearch Industrial Division of the Garrett Corp.

Basically, the turbocharger utilizes the tractor's exhaust gases to force more air into the engine cylinder by means of a turbine driven compressor. The unit increases engine power . . . reduces fuel consumption . . . cuts down smoke and engine roar.

The turbocharger operates at temperatures in excess of 300 F and engine oil pressure is 20 psi. The manufacturer avoided oil seal trouble by specifying Silastic O-rings because they maintain a positive seal and stay resilient despite repeated exposure to oil at elevated temperatures.



Because Silastic stays rubbery from —130 to 500 F and is resistant to weathering, corrosive atmospheres, many fuels, oils and chemicals, it is finding growing use as a sealing material in the aircraft, automotive, appliance, electrical and process industries. * T.M. REG. U.S. PAT. OFF. **No. 496**

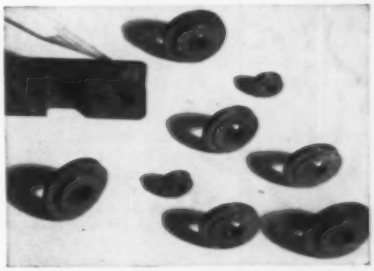
LUBRICATING A SOUND TRACK

Prolonging the life of recording heads on magnetic tape recorders posed a tricky lubricating problem for EMC Laboratories, St. Paul, Minn. But their ingenious use of Dow Corning 200 Fluid turned the trick and helped them market a new product.

Dust, grime, grit and friction can quickly wear out the head of a magnetic tape recorder unless it is adequately lubricated. In addition, certain combinations of temperature and humidity will cause the tape to vibrate, in turn distorting the sound or even resulting in an audible squeal.

EMC Laboratories set out to eliminate these problems by developing a suitable lubricant. The company tested a variety of organic oils and greases and found that all of them oxidized and hardened, ruining the responsivity of the equipment.

EMC finally found the desired properties in oxidation-resistant Dow Corning 200 Fluid and developed an excellent lubricant now sold under the trade name "Long Life." The lubricant puts such a thin silicone film on magnetic tape that it's virtually unmeasurable, but very effective and durable. **No. 497**



No Costly Machining of Parts

Designers have found a way to increase reliability of electrical components and at the same time cut cost of production. How? Mold parts of Dow Corning silicone molding compound. Case in point: the electric cockpit heater manufactured by Janco Corporation of Burbank, California.

(Cont. Pg. 2)

FOR DATA RELATING TO THESE ARTICLES, CIRCLE REFERENCE NUMBER IN COUPON ON NEXT PAGE

MORE

DOW CORNING CORPORATION

Silicone News

NEW LITERATURE AND TECHNICAL DATA ON SILICONES

1958 Guide to Dow Corning Silicones—consists of 16 pages filled with data and illustrations suggesting ways in which you can cut costs, simplify designs, improve performance and add new sales appeal to your products with Dow Corning Silicones. Cross indexed for handy reference, this all-new Guide includes properties and uses for the silicone products developed in recent months. *No. 500*

Silicones as Dielectrics. Just published. A 12 page, fact-filled must for design engineers. It's a convenient selection guide to the silicone dielectric most adaptable to particular applications that range from electronic components and assemblies to power distribution equipment and motors. *No. 501*

Silastic RTV vulcanizes at room temperature. It provides a means of using silicone rubber in those applications where a heat cure is impractical or cannot be tolerated. Available in different consistency grades, Silastic RTV retains good physical and dielectric properties. *No. 502*

Silicone Coating for paper and paperboard aids packagers and processors of sticky materials — it keeps gummy and tacky materials from sticking to all types of bags, boxes, innerliners, wrappings and interleaving sheets — it will not migrate nor contaminate goods in contact with it. Send for informative brochure containing sample papers. *No. 503*

Silicone Bearing Grease, Dow Corning 44, provides long-time lubrication of ball bearings operating from —40 to 400 F. A brochure includes description of properties and case histories which show that 44 Grease helps cut maintenance costs by lubricating where petroleum greases quickly fail. *No. 504*

"Rubber From Rock," a new color-sound movie, explains how Silastic, the Dow Corning silicone rubber, is manufactured from quartzite. Demonstrates why parts fabricated from Silastic retain rubber-like properties from —130 to over 500 F in a wide variety of military and industrial applications. Also covers uses for Silastic as a dielectric in electronic and electrical equipment. To arrange for a showing of "Rubber From Rock" in your plant, circle *No. 505*

NEW FOAM-IN-PLACE INSULATION

A new silicone resinous foam takes most of the work out of installing thermal insulation. To get an effective barrier against heat and cold, simply pour the ready-to-use silicone resin powder in place, apply heat and it foams, filling the available space. No cutting — no fitting — no trimming!

Here, for example, is the way Consolidated Electrodynamics Corporation, Pasadena, California, utilizes this new silicone resin to simplify production and increase the efficiency of a Process Moisture Monitor. An ultra-sensitive unit designed to detect the presence of water or water vapor in any chemical process steam, the Monitor measures and reports the presence of less than one part water per million.

Accuracy like this depends on the Monitor's internal sampling system being kept at a constant temperature regardless of conditions around the unit or sudden temperature changes in the stream itself. After comparing various thermal insulators, Consolidated found the new silicone foam to be by far the easiest-to-use and the most effective insulation.

To insulate the housing cover, the inside is partially plugged with a solid mandrel and one-third of the remaining void is filled with Dow Corning R-7001. Heating turns the powder into a liquid and makes it foam to fill the void.

MORE FACTS: Foamed structures made from Dow Corning silicone resin have good physical and dielectric properties at temperatures far beyond the range of organic materials. Nonflammable, they have low thermal conductivity and low water absorption. *No. 498*

NO COSTLY MACHINING *(Cont.)*

A self-contained floor heater, this unit provides auxiliary heat for the crews on Convair's 340 and 440 commercial airliners. Janco recently switched to high temperature Dow Corning silicone molding compound as the material for insulator washers and fuse link blocks in the heaters. Result: greater reliability, reduced maintenance and lower production costs.

Here's why. The silicone parts can be molded into ready-to-use shapes, require no machining. The reject rate has dropped to practically nothing. Performance-wise, the silicone molded parts resist heat much better than the former material and are ten times stronger!

Silicone molding compound has many potential applications on missiles, jet engines and brakes because it's lighter, does not conduct heat like metal and is more corrosion-resistant. *No. 499*

Dow Corning Corporation, Dept. 684, Midland, Michigan

Please send me: 496 497 498 499 500 501 502 503 504 505

NAME _____

TITLE _____

COMPANY _____

STREET _____

CITY _____ ZONE ____ STATE _____

SILICONE NEWS is published for product design and development engineers by

first in silicones

Dow Corning CORPORATION

MIDLAND, MICHIGAN

ATLANTA BOSTON CHICAGO CLEVELAND DALLAS DETROIT LOS ANGELES NEW YORK WASHINGTON, D. C.

CANADA: DOW CORNING SILICONES LTD., TORONTO GREAT BRITAIN: MIDLAND SILICONES LTD., LONDON FRANCE: ST. GOBAIN, PARIS

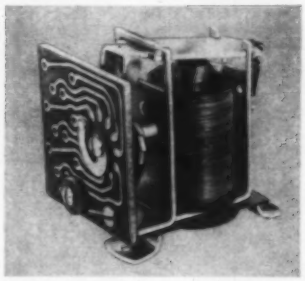
contained. When energized, output and input shafts are coupled together; both shafts are free running when de-energized. Standard voltage is 24 to 28 v dc. Clutch is applicable to tape-recording equipment, calculating machines, coin changers, and other automatic controls. **Autotronics Inc.**, Dept. 12, Box 812, Rte. 1, Florissant, Mo. I

Circle 868 on Page 19

Stepping Relay

uses printed-circuit board for switching currents

SA stepping relay can be furnished for ac or dc voltage operation. It uses a printed-curcuit board for switching currents up to 250 ma. Relay operates on 3 w dc or 20 v-a ac. Ac relay must be pulse operat-



ed; dc coil, normally pulse operated, withstands 3 w continuously. Armature-driven pawl operates a ratchet to drive a movable arm in steps of 30 deg over twelve nonshorting printed-circuit strips. **Technical Information Dept., Potter & Brumfield Inc.**, Princeton, Ind. J

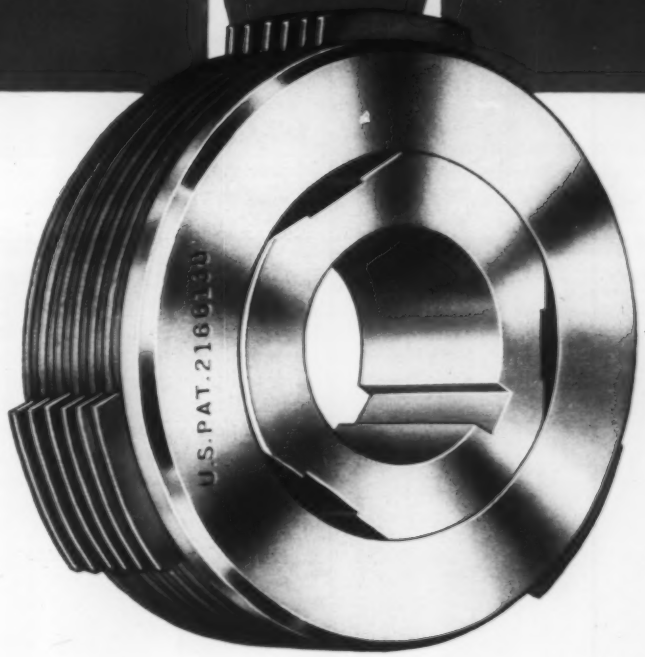
Circle 869 on Page 19

Hose Ends

push-on units incorporate barbed insert

Easier hose assembly is possible with new Barb-Tite push-on hose ends. Hose is pushed onto barbed inserts and assembly is ready to use; skiving of hose is eliminated. Units are machined from tough, dense extruded bar stock. Insert provides positive-grip, leakproof seal which withstands pressures to 250 psi with minimum burst pressure of 1000 psi. Designed for repeated use, hose ends have a wide range of industrial and automotive applications, such as in fuel, oil, air, and vacuum-gage lines.

Maxitorq Disc-pac...
the pre-packaged clutch or brake assembly



Takes performance guesswork out of power transmission design

With these performance-proved units, you can save time and money in designing and building clutches and brakes exactly tailored to the requirements of your application. At the same time, you can be sure that they will equal the performance and smooth operation of proved MAXITORQ clutches and brakes. DISC-PACS are simply the "heart" of a clutch or brake . . . the discs, separator springs, and locking plate . . . supplied as a complete self-contained unit for the convenience of design engineers and equipment builders.

Produced in a full range of sizes and capacities from ¼ h.p. to 15 h.p. Bulletins available on other MAXITORQ products: Floating Disc clutches and brakes, Electric clutches, Overload Release clutches, low-cost Single Disc clutches, and clutch or brake friction discs. Write Dept. MD-4.

THE CARLYLE JOHNSON MACHINE CO.
Manchester, Connecticut

1CJ58

Circle 520 on Page 19

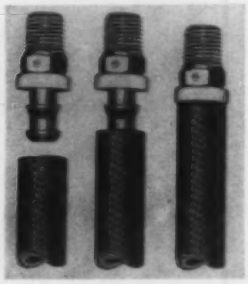
BEAVER
BALL SCREWS

Successor to the Acme screw drive and preferred in many applications to hydraulic and pneumatic systems. Guaranteed 90% efficient in converting rotary twist to linear push (or vice versa). Employs a stream of precision balls and ground lead to eliminate drag and wear in delicate instruments, aircraft, machine tools, massive wind tunnel jacks, etc. For horizontal and vertical actions, indexing, inching and traversing. Consultation and engineering service available. Write for literature.

• EXTREME ACCURATE POSITIONING • NO BACKLASH • RAPID START • ANY DIAMETER OR TRAVEL •

Beaver Precision Products INC.
CLAWSON, MICH.

Circle 521 on Page 19



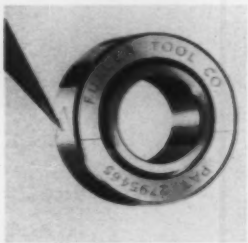
Sizes from 1/4 through 3/4 in. ID are available. **Ft. Wayne Div., Weatherhead Co.**, 128 W. Washington Blvd., Ft. Wayne, Ind. J

Circle 870 on Page 19

Self-Aligning Bearing

precision-ground unit eliminates backlash

New self-aligning bearing features an interlocking race with 100 per cent contact between race and ball, and tolerances as close as 0.0002 in. It is for applications in actuators and linkages on aircraft, missile, and military assemblies, in marine applications, and other uses where elimination of backlash is important. Closest tolerances are supplied in any metal that can be machined. Bearing can be adapted to



high-temperature requirements, has excellent wearing qualities, and withstands severe shock. **Fuller Tool Co.**, 4000 Eleven Mile Rd., Berkley, Mich. H

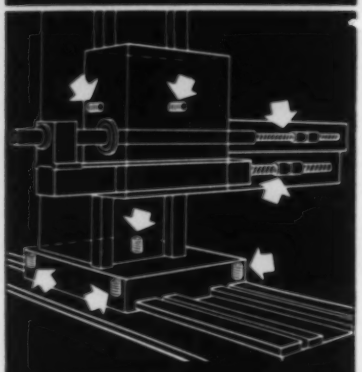
Circle 871 on Page 19

Selenium Rectifiers

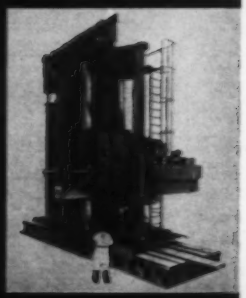
miniature units have clip assembly

Vac-u-Sel miniature selenium rectifiers are rated at 2.5, 8, and 25 ma. The clip-assembly rectifiers are designed for application in half-wave circuits, and can be used in small appliances, low-power control devices, electric instruments, and sim-

Versatility!



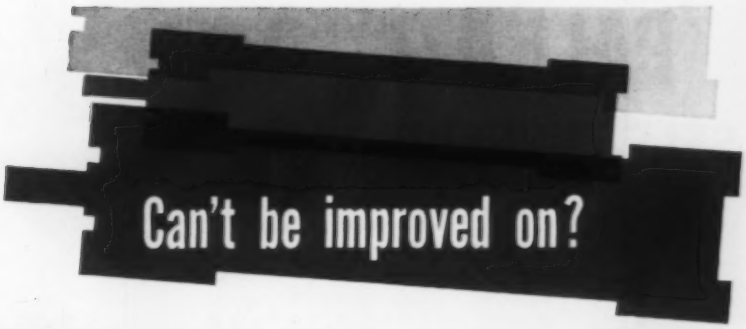
THE WORLD'S LARGEST FLOOR TYPE HORIZONTAL BORING - DRILLING - MILLING MACHINE USES 6 BEAVER BALL SCREWS FOR POSITION CLAMPING AND 2 FOR SPINDLE FEED



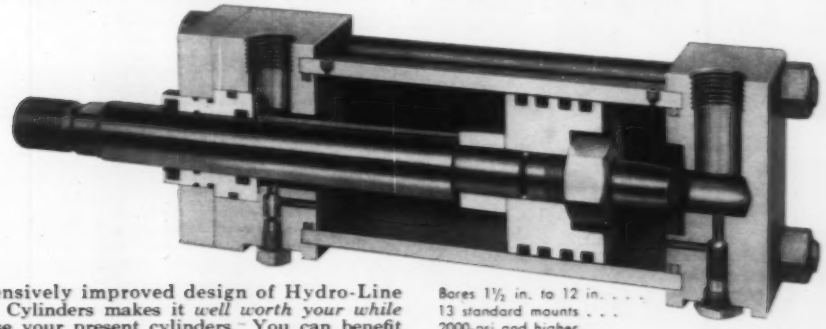
The same accurate positioning, rigidity and freedom from backlash essential in this huge Giddings and Lewis Model 1210-FUAR with 10" spindle is available to you for improving the efficiency of your equipment. Consultation and engineering service. Write for literature.

Beaver Precision Products INC.
CLAWSON, MICH.

Circle 521 on Page 19

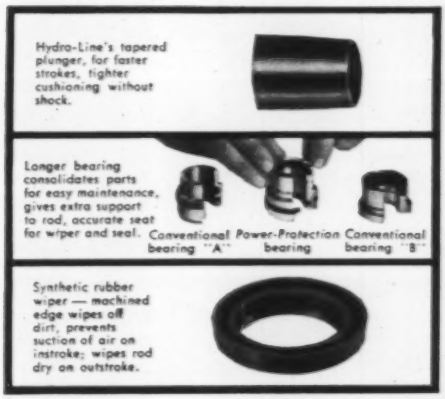


NEW POWER-PROTECTION DESIGN OF SERIES "N" CYLINDERS CUTS "UNAVOIDABLE" PROFIT LEAKS



Comprehensively improved design of Hydro-Line Series "N" Cylinders makes it *well worth your while* to reappraise your present cylinders. You can benefit from improved design in one or more of these areas.

Bores 1½ in. to 12 in. . . . 13 standard mounts . . . 2000-psi and higher operation


Hydro-Line's tapered plunger, for faster strokes, tighter cushioning without shock.
Longer bearing consolidates parts for easy maintenance, gives extra support to rod, accurate seat for wiper and seal.
Conventional bearing "A"
Power-Protection bearing
Conventional bearing "B"
Synthetic rubber wiper — machined edge wipes off dirt, prevents suction of air on instroke; wipes rod dry on outstroke.

EFFICIENCY — Are you accepting any of the following causes of power loss or imperfect performance: Imperfect oil bypass control for specific operating conditions? Poor cushioning at end of stroke or reduced speed at start? Oil leakage? Unnecessary bearing or piston friction? . . . *Every* Series "N" Cylinder offers improved protection against *all 5 of these factors* and can increase profits by increasing the amount and the dependability of power delivered!

MAINTENANCE — Downtime is dead loss. How much of it must you write off each month because of slow or complicated cylinder servicing? Lack of flexibility and interchangeability of cylinder parts? Air or dirt entering cylinders on the instroke? Imperfect bearing lubrication? Scoring or corroding of rod? . . . Series "N" Cylinders offer *11 improved features* to help keep your machines producing longer between maintenance periods . . . speed and simplify parts replacements when needed!

SERVICE LIFE — Do you receive the maximum available number of *efficient* cycles from your present cylinders in return for the initial price you pay and the time it takes to install them? Series "N" Cylinders are unsurpassed for quality of materials and construction — and a combination of *4 distinct life-extending design improvements* place them definitely ahead of conventional cylinders for length of service at *full* efficiency.

Call your nearby Hydro-Line representative today — ask for a demonstration of the *Power-Protection* features of Series "N" High-Pressure Cylinders.

HL CYLINDERS

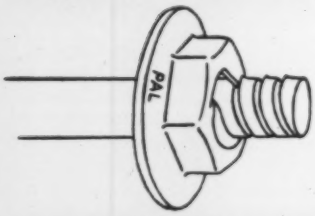
HYDRO-LINE MANUFACTURING COMPANY

5600 PIKE ROAD — ROCKFORD, ILLINOIS

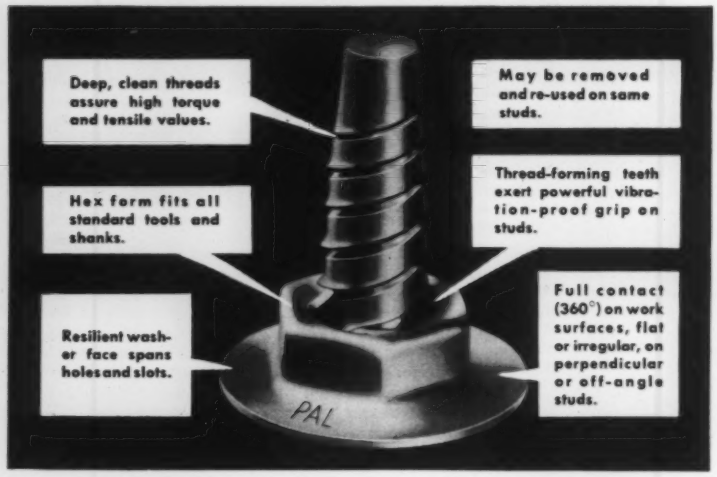
manufacturers of: high- and low-pressure hydraulic cylinders • heavy-duty air cylinders • adjustable-stroke cylinders • dispensing cylinders • intensifiers • single-acting cylinders • booster cylinders

PALNUT®
SELF-THREADING LOCK NUTS

make their own threads

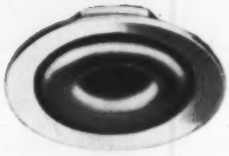


on straight or tapered unthreaded studs, rods, rivets or wire of steel, zinc, aluminum or brass.


Deep, clean threads assure high torque and tensile values.
May be removed and re-used on same studs.
Thread-forming teeth exert powerful vibration-proof grip on studs.
Hex form fits all standard tools and shanks.
Full contact (360°) on work surfaces, flat or irregular, on perpendicular or off-angle studs.
Resilient washer face spans holes and slots.
PAL

Now, in a single high-speed fastening operation, you can form your own threads while tightening PALNUT Self-threading nuts on low-cost unthreaded studs or rods. No special tools or skills needed. High speed assembly is obtained with standard tools and methods. Parts are pulled up tight with a resilient spring locking action that will not loosen in service.

PALNUT Self-threading Nuts are made of spring-tempered steel, comprising a thread-forming lock nut and flat washer in one piece. Available in sizes for ⅛", 3/16" and ¼" dia. studs and rods, in various washer diameters. Write for free samples and descriptive literature.



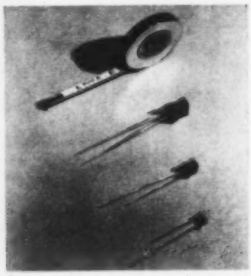
Also available with "bonded-in" plastisol compound to seal out water and dust.

THE PALNUT COMPANY, 75 Glen Road, Mountainside, N. J.
In Canada: P. L. Robertson Co., Ltd., Milton, Ont.

PALNUT® LOCK NUTS FASTENERS PAL®

Quick, secure fastening at low cost

ilar electronic devices which require small amounts of dc power. Three models are available in ratings from



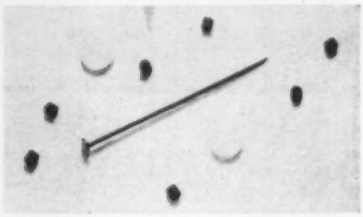
37 to 378 v peak inverse voltage. They operate in temperatures to 110 C. General Electric Co., 1 River Rd., Schenectady 5, N. Y. C

Circle 872 on Page 19

Synthetic-Rubber Parts

subminiature units are custom molded

Subminiature synthetic-rubber parts are molded to dimensions held within extremely close tolerances. They are custom molded from most synthetic-rubber materials used for O-rings, as well as from specialized



materials developed for the electronics industry. Rubber Div., Parker-Hannifin Corp., 17325 Euclid Ave., Cleveland 12, Ohio. F

Circle 873 on Page 19

Vinyl Electrical Tubing

transparent material is for low-temperature use

No. 3022 clear vinyl electrical tubing is fungus resistant, flame retardant, and is for low-temperature use. Tubing meets requirements of MIL-I-7444. It is available in tubing size ranges I, II, and III, and has low-temperature ASTM brittle point of −100 F with maximum operating temperature of 185 F. Material has dielectric strength of 300 v per mil, tensile strength of 2000 psi, elongation of 300 per cent, and

(Advertisement)

Applying Reliance V*S Drives in Designing Web-fed Equipment

by:
C. E. Robinson, E.E.
Section Manager
Application Engineering Dept.
Reliance Electric & Engineering Co.

A primary consideration on web-fed equipment is to maintain web continuity. If too much tension is exerted, the web will stretch or break, causing product imperfection or requiring machine rethreading. Too little tension will cause wrinkling or slack pile-up.

Reliance V*S Drives are ideal for driving and controlling web-fed processing equipment. Acceleration and deceleration rates can be programmed to prevent over and under tensioning during speed change, a critical condition for web-fed operations. Motor operating speeds can be automatically regulated to maintain correct tension under any conditions, even dead stall.

STARTING AND STOPPING PROTECTION

Figure 1 shows a typical operating cycle of a specialty printing press. This press prints and die cuts milk cartons. Paper stock is fed from a roll, and printing is done on a continuous web of paper.

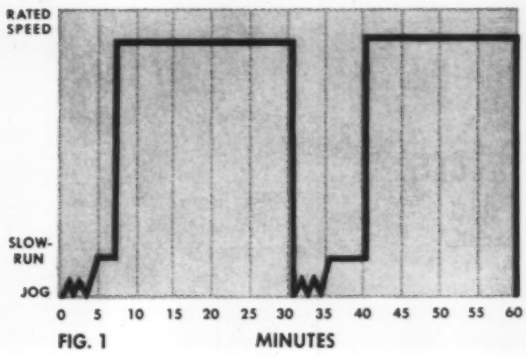


FIG. 1

A 30 hp. V*S Drive powers the press, providing speeds from jog and slow-run up to full operating speed. Speed changing is stepless and the rate of change is carefully regulated by a Reliance VSC exciter. The VSC applies voltage gradually to the motor, providing preset, automatic, linear acceleration. This press starts and stops about three times an hour. Any tearing or looping of the paper would seriously decrease production. The V*S Drive eliminates this danger.

TENSION CONTROL DURING OPERATION

Figure 2 shows a comparison between line speed and motor speed on the beamer of a textile slasher. In order to prepare the thread for weaving on the loom, it is put through a slashing operation. This consists of immersing thousands of individual strands in hot sizing, and winding them onto a wide roll or beam. Between the bath and the beamer are delivery rolls to tension the threads as they are wound.

A 5 hp. V*S drives the beamer, keeping unvarying tension on the delicate threads. Drive motor speed decreases during winding, maintaining constant tension as the roll builds. A Reliance VSR Regulator, through a feed-back loop, measures and controls the current drawn by the motor. As the beam builds up, the motor tries to draw more current. By keeping the current constant, the motor slows down in direct relationship to the build up of the beam. The V*S Drive will hold a constant tension from start to stop. If a mechanical jam should stop the slasher, the VSR will maintain tension even with the motor stalled.

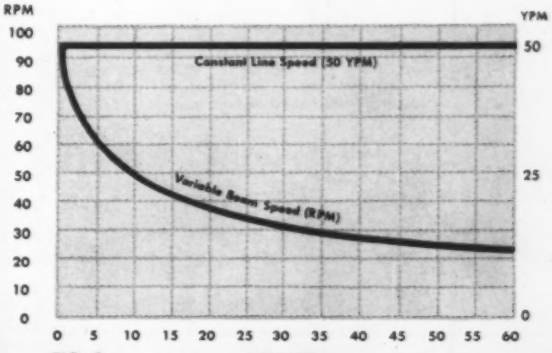


FIG. 2

V*S DRIVE COMPONENTS

A V*S Drive operates from standard a-c. power lines and consists of three basic components: d-c. drive motor, packaged motor controls and operator's control station.

Reliance drive motors change speed over a wide range, smoothly and without speed steps. The all electric design permits the inclusion of built-in dynamic or regenerative braking, giving fast, maintenance-free stopping power.

Motor-generator sets or electronic rectifiers, working from plant a-c. power lines, form the nucleus of the motor control unit. A series of built-in controls regulate voltage and current in the system. With these controls, any required combination of speed, horsepower, torque and time characteristics are produced.

If you would like further information on how you can use V*S Drives when designing your product, contact your local Reliance representative, or write for Bulletin No. D-2506. D-1585

RELIANCE ELECTRIC AND ENGINEERING CO.
Dept. 284A, Cleveland 17, Ohio
Canadian Division: Toronto, Ontario
Sales Offices and Distributors in principal cities

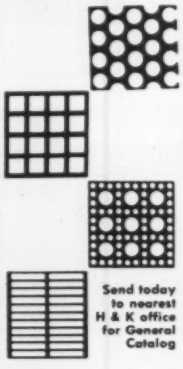
*Product Development by William M. Schmidt Associates.

H & K perforated metals serve a function of design

The orientation of television, AM-FM radio and phonographic elements into one modular housing containing all mechanical, electronic and control devices is one function of the mock-up illustrated. Another is the utilization of H & K perforated metal for the necessary ventilation and sound requirements of such equipment.

H & K Perforated Metal offers the Industrial Designer and other men of ideas, materials that are aesthetically interesting and functionally honest. If perforated materials can be utilized in your product, please contact us. Our sales engineers will be pleased to work with you.

A few of the thousands of H & K patterns are illustrated in reduced size



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Chicago 44, Illinois

New York Office and Warehouse
114 Liberty Street, Dept. MD
New York, New York

Circle 525 on Page 19

You get MORE than accurate counting

with

SODECO Electric Impulse Counters

SODECO just *starts* with counting accuracy. With SODECO Electric Impulse Counters you get many additional built-in advantages which enable you to use them for your toughest counting problems. For example:

SODECO TYPE T Ce Z
Instantaneous Mechanical Reset
● Just touch the toggle—Counter resets to zero.

SODECO TYPE T Ce F
Instantaneous Electrical Reset
● Counter resets electrically—instantly.

- **Fast—counts up to 25 impulses/sec.**
- **Compact—suitable for flush mounting.**
- **Low power demand—used in electronic circuits.**

Both types are available with auxiliary contacts which allow you to connect them to other counters for applications such as batch counting, recycling, etc.

No matter what your counting problem, you can count on SODECO for the answer. Write for complete information.

LANDIS & GYR, INC.

45 West 45th Street, New York 36, N. Y.

Circle 526 on Page 19

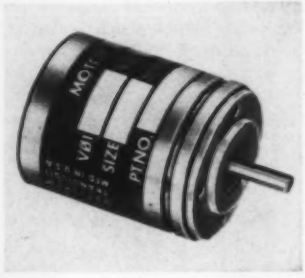
moisture absorption of −0.5 per cent. It resists ultraviolet rays, does not corrode from contact with copper or aluminum, and is self-extinguishing in less than 15 sec as required for aircraft use. Tubing is available in standard coil lengths in sizes from No. 24 through 3 in. ID. **Irvington Div., Minnesota Mining & Mfg. Co.**, 6 Argyle Terrace, Irvington 11, N. J. D

Circle 874 on Page 19

Miniature Motor

60-cycle unit provides rapid response

Miniature Size 11 servo motor, 1.062 in. in diam, weighs 4.5 oz and develops stall torque of 1.0 oz-in. Developed for commercial instrumentation applications, unit provides rapid response on 60-cycle power. Control phase can be wound for optimum performance with direct transistor drive. Motor is available



either as a unit or as a servo assembly combining synchros, amplifiers, gear trains, and accessories such as slip clutches, cams, internal stops, and switches. **Daystrom Transicoil Corp.**, Worcester, Montgomery County, Pa. E

Circle 875 on Page 19

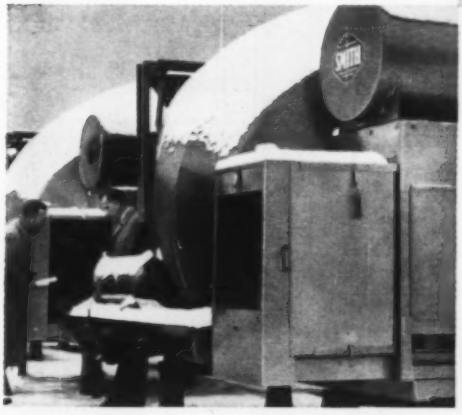
Printed-Circuit Connector

accepts boards from 1/16 to ⅛ in. thick

Series 600-93 printed-circuit connector with bellows-action contacts accepts printed-circuit boards that vary in thickness from 1/16 to ⅛ in. Spring-grip action is positive over entire printed-circuit contact area, with no distortion or stress evident. Self-alignment of contacts allows for any residual warpage of printed-circuit board. Molding of glass-reinforced Plaskon Alkyd 446

why T. L. Smith Co. powers with Chrysler Industrial Engines

T. L. SMITH EXECUTIVES, Richard R. Kupfer, Director of Purchases (left); Raymond W. Mueller, Project Engineer, inspect Chrysler Ind. 30 Engine which powers all T. L. Smith separate engine mixers—nine models, 5 to 9 yard capacity.



SEND for 1958 CHRYSLER INDUSTRIAL ENGINE CATALOG: Dept. B4, Industrial Engine Division, Chrysler Corporation, Detroit 31, Michigan.

Ready-mix concrete mixers demand rugged power. Most work, for example, is off the road and the mixer engine is subjected to severe jolting and sudden load shifts. The engine is also forced to operate in an atmosphere of abrasive cement dust. The engine is required to turn drum loads ranging up to 40,000 lbs. Operating speeds fluctuate suddenly from 2400 rpm during loading to 800 rpm during agitation.

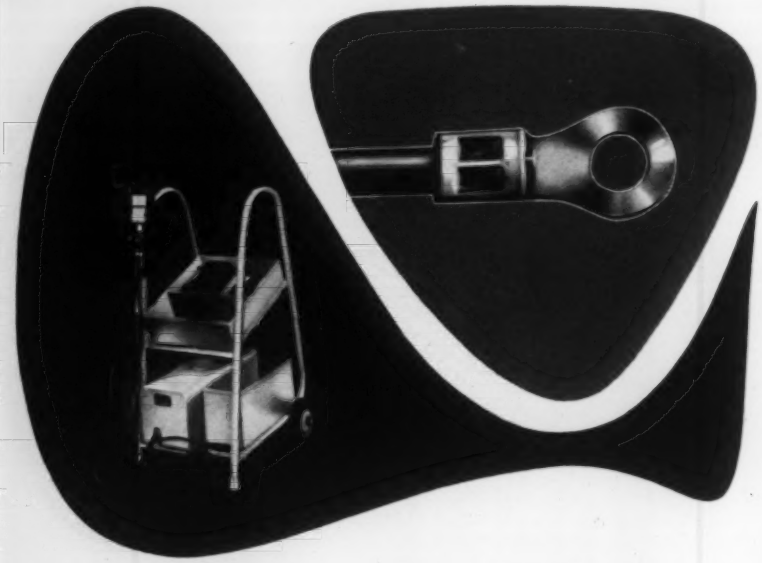
T. L. Smith Co. has found that Chrysler Industrial Engines are engineered and built to meet these rugged demands better than any other engine in the field. Chrysler's fluid coupling, for example, absorbs sudden load shocks, prolongs engine life. Chrysler's efficient oil-bath air cleaner keeps harmful cement dust from fouling the engine. Chrysler Engines have also proved able to operate at continuous low speeds under heavy loads for long periods without excessive carbon build-up. Most important, Chrysler's day-in, day-out dependability means minimum down time for T. L. Smith customers. In fact, many Chrysler-powered units which are still on the job after six and seven years have never had a major maintenance problem.

Chrysler
INDUSTRIAL ENGINES
INDUSTRIAL ENGINE DIVISION • CHRYSLER CORPORATION

Circle 527 on Page 19

AMP® SOLISTRAND® Terminals

and DYNA-CRIMP® tools—



the right combination . . .

for electrical power generation and distribution

Take any assortment of conductors—solid, stranded or irregularly shaped. Add one A-MP Solistrand terminal. Bring them together in the proper A-MP Dyna-Crimp tool.

The result is always the same—an electrically-perfect, crimp-sure attachment at lower installed cost. Top performance even in adverse conditions.

And Solistrand needs no servicing. This is especially valuable where you have power machinery that must be left unmanned for long periods. Check these important Solistrand features:

- Exclusive double-indented crimp weds Solistrand barrel to conductors in a never-fail attachment.
- Crimping action of Dyna-Crimp tools forces combinations of conductors into one homogeneous mass. It does this at exactly the right pressure—no more, no less—for maximum conductivity and maximum strength with no weakening of conductors.
- Solistrand terminals are scientifically engineered in sizes to fit wires from No. 22 to 600 mcm.

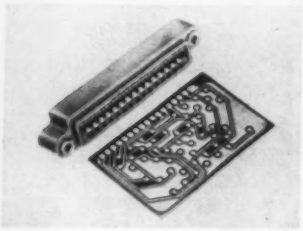
And to serve you better, AMP maintains an international staff of field engineers capable of solving all your terminal problems.

Write for our Solistrand terminal and connector catalog.

AMP INCORPORATED

General Offices: Harrisburg, Pennsylvania

A-MP products and engineering assistance are available through wholly-owned subsidiaries in: Canada • England • France • Holland • Japan



is supplied with passivated, stainless-steel mounting bushings which allow for self-alignment. Fifteen contacts have solder-lug terminations for No. 20 AWG wire. **Electronic Sales Div., DeJur-Amsco Corp.**, 45-01 Northern Blvd., Long Island City 1, N. Y. D

Circle 876 on Page 19

Aluminum Sheet Alloy

for auto and appliance decorative trim

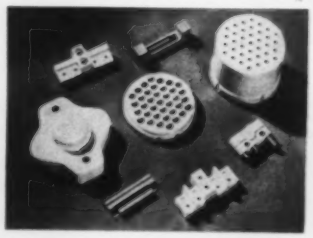
Aluminum sheet alloy, designated X5457, provides a lustrous, mirror-like appearance when polished, brightened, and anodized. It is particularly suitable for decorative trim applications in the automotive and appliance industries. Alloy exhibits mechanical properties similar to Alloy 5357 and can be rolled to the same manufacturing specifications. **Aluminum Co. of America**, 730 Alcoa Bldg., Pittsburgh 19, Pa. F

Circle 877 on Page 19

Plastic Materials

have high heat resistance and low dissipation factor

Two new diallyl-phthalate plastic materials withstand continuous temperatures to 500 F. Diall FS-4 is a long-fiber, glass-filled molding compound which shows flexural strength of 6700 psi, compressive strength of 6500 psi, and tensile strength of 4270 psi at 500 F. Diall FS-5 is a short-fiber, glass-filled compound which at 500 F has flexural strength of 2000 psi, compressive



Rubber Bonded-to-Metal Parts

Precision know-how, care, and special bonding techniques assure you of parts that will reduce assembly costs, improve product operation and simplify design.

Just send your problems—your blueprints to Precision for solution. Our engineering staff will be glad to make recommendations and quote to your requirements.

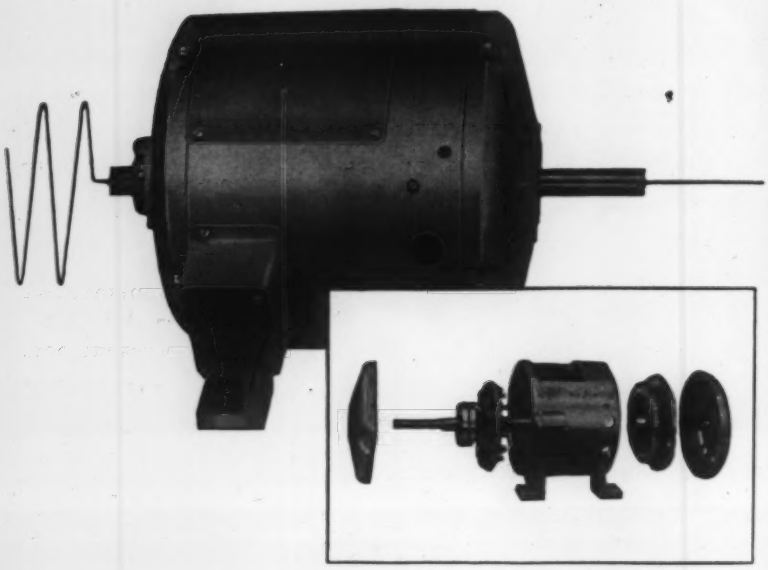
Specify Precision — first in quality

Precision Rubber Products Corporation

"O" Ring and Dyna-seal Specialists

Box 431, Oakridge Drive, Dayton 7, Ohio **Canadian plant at: Ste. Thèrése de Blainville, Québec**

SPECIAL



rotary rectifier for speed control

This is a unique, commutating device, specially built by ESCO, to provide a signal used for accurate, wide-range speed control for a variable frequency alternator.

It's a rectifier because it supplies a DC speed control current from an AC alternator output. Special windings in the alternator impress a "revolving voltage" on a fixed commutator within the device. Rotating brushes collect this voltage, in proper synchronization, to deliver a DC output through two slip rings. This output is exactly proportional to the air gap flux of the alternator and is used to control the drive motor speed. This particular method was chosen for its exceptionally smooth, accurate control over a wide speed range from well below 100 rpm to above 4,000.

This is typical of ESCO's unusual ability to design special rotary equipment to meet customer needs. Whether or not your problem is this special, remember ESCO's forty years of broad experience is always available to you. No motor or generator problem is too big or small, too routine or specialized for ESCO engineers and craftsmen.

Refer to Esco Catalog in section 4a/EL in Sweet's Product Design File, or write direct for general catalog No. 56PD. Why not also send us details on your special problem . . . we'll be glad to show you how we would go about solving it for you.

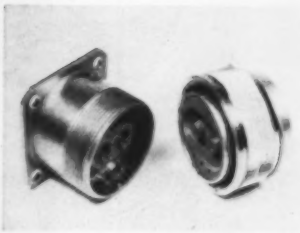
ESCO ELECTRIC SPECIALTY CO.
179 South Street, Stamford, Conn.

strength of 6000 psi, and tensile strength of 4500 psi. Both materials are up to five times stronger at 80 F. They exhibit high insulation resistance and dielectric strength, high arc resistance, low dissipation factor, low water absorption, immunity to fungus, and resistance to solvents, acids, and alkalis. Applications include potentiometers, switches, connectors, and other electrical components. Typical applications are shown. **Mesa Plastics Co.**, 11751 Mississippi Ave., Los Angeles 25, Calif. L

Circle 878 on Page 19

High-Voltage Connector

carries 7500 v



New high-voltage connector utilizes miniaturized, gold-plated pins and sockets. Designed to carry 7500 v, it has a molded-in insert with two high-voltage contacts and three low-voltage carriers. Receptacle is a large, 2-in., square-flange type. Connector is sealed according to standard AN-E methods. Solder-pot ends can be potted to make unit completely environmental. **Deutsch Co.**, 7000 Avalon Blvd., Los Angeles 3, Calif. L

Circle 879 on Page 19

Cylinders

for temperatures from −20 to 500 F

Standard air and hydraulic cylinders have applications such as heat treating, drying and annealing ovens, furnaces, foundries, brakes and clutches, glass-making operations, diecasting, and high-temperature process operations of many different kinds. Use of high-temperature packings and silicone greases permits operation at temperatures from −20 to 500 F. Maximum pressure service rating for the air cylinders is 150 psi, for hydraulic units, 350 psi. Size range is 1½ to

Circle 530 on Page 19

I'M SPECIFYING INTERNATIONAL POWER FOR OUR NEW MODEL X1A
GOOD! OUR CUSTOMERS ARE ALREADY SOLD ON IT!
AND IT'S BACKED BY WORLD WIDE SERVICE
WE CAN COUNT ON PROMPT DELIVERY, TOO!

Power—your easiest decision in designing that new product!

Call THE MAN FROM INTERNATIONAL for product power—surest way to satisfy your customers, sales manager, service manager, and purchasing agent

You make so many important decisions in developing a new product that it's good to know you can decide on International power for your machine and please everybody that matters.

Your decision for International, for example, will please your sales manager. He knows International needs no pre-selling to customers, that this famous heavy-duty power is as dependable as it is economical.

Your service manager is sure to concur with your decision for he knows International power is supported in the field by the finest in world-wide parts and service facilities.

Likewise, your purchasing agent knows he can get very special delivery service on International power to prevent any production delays.

Call THE MAN FROM INTERNATIONAL for facts on any of the twenty V-8, 4- and 6-cylinder diesel and carbureted engines he sells. You can contact him today by calling his headquarters in Melrose Park, Illinois—Fillmore 3-1800.

INTERNATIONAL®

International Harvester Company
180 North Michigan Ave., Chicago 1, Ill.

CONSTRUCTION EQUIPMENT

A COMPLETE POWER PACKAGE: Crawler and Wheel Tractors . . . Self-Propelled Scrapers . . . Crawler and Rubber-Tired Loaders . . . Off-Highway Haulers . . . Diesel and Carbureted Engines . . . Motor Trucks . . . Farm Tractors and Equipment.

Circle 531 on Page 19

1958
design
engineering
show

April 14 - 17
Chicago

At the show...

FIND OUT WHAT THESE PUMPING GEARS CAN DO FOR YOU!

STANDARD PUMPS — A large selection for hydraulic or processing equipment . . . pressure lubrication . . . fuel transfer . . . or you name it! Including all categories, you choose pumps in capacities from 5 to 300 GPM — pressures to 1000 PSI.

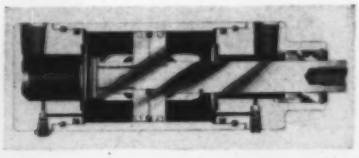
SPECIAL PUMPS — Many customers have effected great savings by having Roper modify a standard pump into a Roper "special" pump. A thorough analysis of your specifications will tell whether this is the practical approach to your requirements.

CUSTOM PUMPS — In these units, Roper employs the basic, tested principle of two equal size gears running in a precision fitted case. When the job is so complex only a custom pump will do, then depend on Roper to help you achieve the results you want.

NOT GOING? SEND FOR CATALOG

ROPER HYDRAULICS, INC.
224 Blackhawk Park Ave.
Rockford, Illinois

ROPER
ROTARY PUMPS



8-in. bore with stroke lengths to 18 ft. Cushioned and noncushioned models are available. Use of a key-type stainless-steel locking ring permits 360-deg rotation of pipe parts. **Carter Controls Inc.**, 2800 Bernice Rd., Lansing, Ill. J

Circle 880 on Page 19

Precision Balls

for use at elevated temperatures

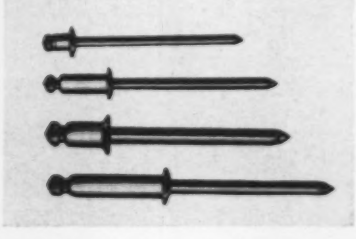
Wide range of precision balls operate at elevated temperatures. Alloys include T-1, T-2, T-5, M-2, M-10, M-50, cobenium, modified 440, stellite, and Inconel. They are made to tolerances as close as 10 x 10^{-6} in. **Hartford Steel Ball Co. Inc.**, Drawer Q, Station A, Hartford 6, Conn. B

Circle 881 on Page 19

Blind Rivets

of cadmium-plated steel

POP blind rivets are now available in high-strength, cadmium-plated steel. They develop ultimate strengths up to 730 lb. Seven sizes



are available in various lengths and diameters of 1/8, 5/32, and 3/16 in. **United Shoe Machinery Corp.**, 140 Federal St., Boston 7, Mass. B

Circle 882 on Page 19

Oil-Level Gages

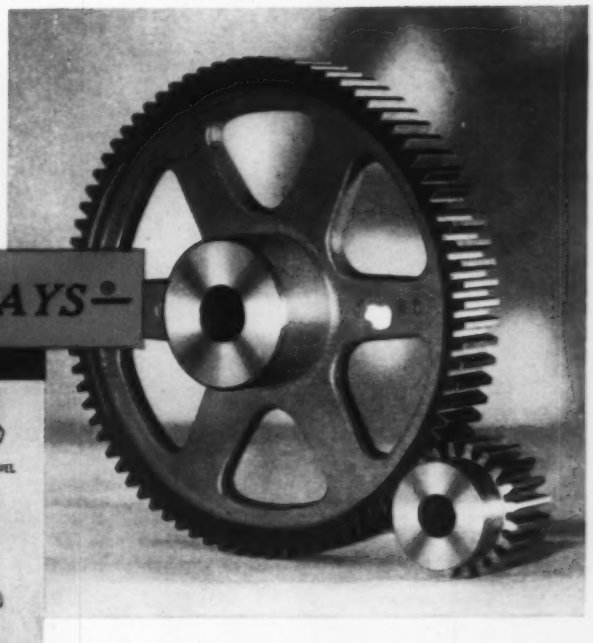
incorporate sight glasses

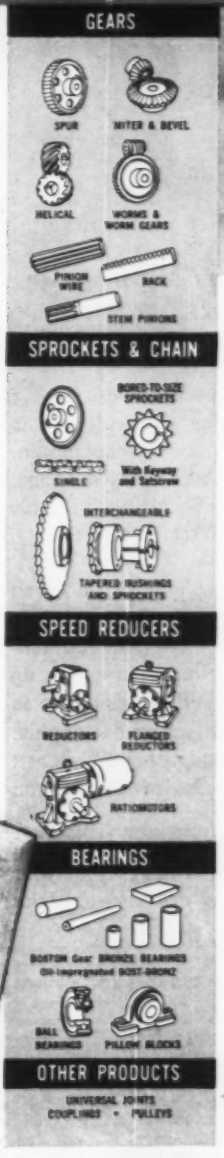
Line of oil-level gages, comprising 11 types and 77 sizes, is machined from quality brass. Sight glasses are tightly gasketed to assure long, leakproof service. Styles avail-

Circle 532 on Page 19

Plan for extra savings
when you design
power transmission drives
. . . remember

—STANDARDIZATION PAYS—





7124
STANDARDIZED TRANSMISSION PRODUCTS
— OFF-THE-SHELF
— AT FACTORY PRICES

Get CATALOG No. 56 for complete listings. Includes 50 pages of engineering data for drive design.

Design around BOSTON Gear®

When you standardize on BOSTON Gear transmission components, you'll be days and *dollars* ahead in drive design.

You simplify planning. Select all the parts you need from one source—the full range of types and sizes listed in the Boston Gear Catalog.

You save time and expense. Order the parts you need from your local Boston Gear Distributor, and get off-the-shelf delivery—from stock—at factory prices.

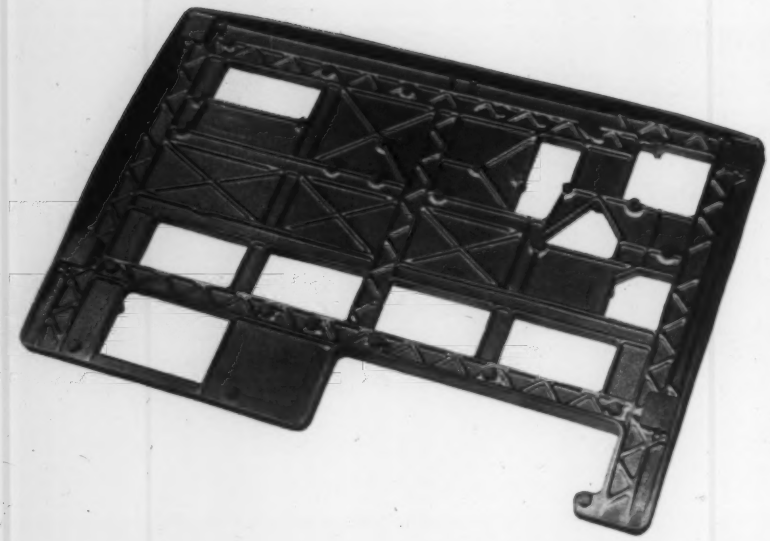
You get top-rated performance. Compare and see why cost-wise buyers agree that Boston Gear products set the highest quality standards.

Why wait (and pay more) for parts "made-to-order?" Your Boston Gear Distributor is fully qualified to help you get the maximum benefits from standardization—in lower costs, in simplified servicing. Boston Gear Works, 64 Hayward St., Quincy 71, Massachusetts.

Visit BOSTON GEAR Booth No. 554
at the DESIGN ENGINEERING SHOW, Chicago

CALL YOUR BOSTON Gear DISTRIBUTOR

For nearest Distributor LOOK UNDER "GEARS" in the "Yellow Pages"



DUCTILITY

A CASE IN POINT—This ninety-six pound casting was made for the National Cash Register Co. of Nodulite®, Hamilton Foundry's ductile iron. The casting forms the base for the new Post-Tronic Accounting Machine. It measures 37½" by 23½" with sections varying from ¼" to 1½". Ductile iron was chosen for this part because of its ductility, dimensional stability, rigidity, and machinability.

Ductile iron has most of the engineering advantages of steel yet it can be designed with the same flexibility and cast with the same procedures used for gray iron. It has high strength: up to 120,000 psi minimum tensile strength in standard grades. It is tough: Charpy impact strengths up to 115 ft.-lbs. in standard grades. It is ductile: elongation is possible up to 25% after short time annealing. And it is wear resistant: spheroidal graphite particles provide for self-lubrication. Hamilton Foundry regularly casts 60-45-10, 80-60-03, 100-70-03, and 120-90-02 grades of ductile iron as well as high alloy Ductile Ni-Resist.

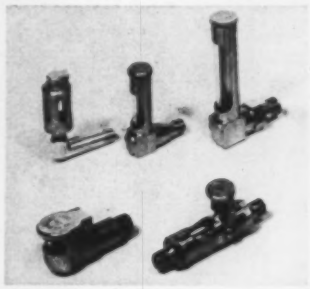
When new and unusual design problems arise in the selection of metal and the casting of parts, you will find that the skill and integrity of your foundry is your best insurance that specifications—and delivery schedules —will be met.

GRAY IRON • ALLOYED IRON • MEEHANITE® • DUCTILE (NODULAR) IRON • NI-RESIST • DUCTILE NI-RESIST • NI-HARD

HAMILTON FOUNDRY

The Hamilton Foundry & Machine Co., 1551 Lincoln Ave., Hamilton, Ohio • TW 5-7491

able include elbow types, gear-case gages, one-piece, forged-brass units, types for horizontal or vertical applications, one-piece units with union couplings, and units which



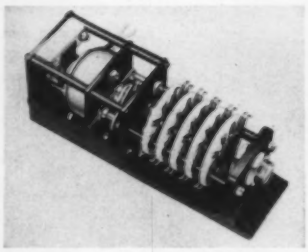
incorporate a needle valve to regulate oil flow. **Gits Bros. Mfg. Co.**, 1846 S. Kilbourn Ave., Chicago 23, Ill. I

Circle 883 on Page 19

Stepping Switch

operates under high temperatures and vibration

New stepping switch, designated the Programmer, meets and exceeds MIL-S-25259 (Proposed). It is available for a variety of engineering projects, including automated production systems, machine tools, and industrial products. Open or sealed, unit operates under extreme temperatures, high altitude, and



severe vibration or shock. It carries 8, 12, 18, or 24 points, up to 16 wafers, and unlimited switching arrangements. **Programation Div., Guardian Electric Mfg. Co.**, 1621 W. Walnut St., Chicago 12, Ill. J

Circle 884 on Page 19

Clutch-Brake

for minimum torque, miniature size uses

Miniature No. 3 clutch-brake combination is for use in computers, office machinery, aircraft equipment,

Can specialized business publication advertising actually sell?

By reputation, salesmen are reluctant to credit anything but their own selling efforts for getting names on the dotted line.

Actually, it's quite a different story. The most successful salesmen will tell you two important things about selling. 1. That the selling process is largely a matter of communicating ideas. 2. And that specialized business publication advertising can help importantly to register information with prospects.

Of course each salesman will express this in his own way . . . but they all agree that selling would be far more difficult without the advertising that appears in the industrial, trade and professional publications that serve the specialized markets to which they sell.

Here, for instance, is what a salesman has to say about this kind of advertising:

Fred Snyder, Cleveland District
Worthington Corporation

sells to industry

Says Mr. Snyder:

"We have, of course, sales leads from our business paper advertising that are forwarded to us on a monthly basis. But also the trade advertising has its impact on many who do not at the time request specific information. Worthington is far better known today than it was five years ago, due in no small measure to the aggressiveness of its advertising and sales promotion department.

"Their work makes my job easier. First of all, we have an entree in companies where some Worthington products were not previously as well-known as our original line. We're getting a lot better sales coverage on all products. The Corporation manufactures so many products today that even regular customers may be unfamiliar with some of these products. Through trade advertising and sales promotion we have been able to sell the whole Worthington line.

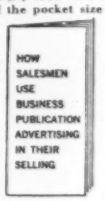
"Getting back to sales leads—they are particularly helpful to our dealers. In Cleveland, W. M. Patterson Supply will undoubtedly receive inquiries from Worthington's advertising. Scott-Tarbell, Inc., Cleveland Oak Belting, or other dealers handling special product lines will pick up leads from our advertising to help them get business.

"I think we've grown eightfold since the war. This year we hit two hundred million. It used to be that twenty-five million was a good year. The advertising and sales promotion department has aggressively been attacking their part of the problem within the last five years. Prior to that the name Worthington was not nearly so well-known and we put much less emphasis on advertising."

Ask your own salesmen what your company's business publication advertising does for them. If their answers are generally favorable you can be sure that your business publication advertising is really helping them sell. If too many answers are negative it could well pay you to review your advertising objectives—and to make sure the publications that carry your advertising are read by the men who must be sold.

How salesmen use their companies' advertising to get more business

Here's a useful and effective package of ideas for the sales manager, advertising manager or agency man who would like to get more horsepower out of his advertising. Send for a free copy of the pocket size booklet entitled, "How Salesmen Use Advertising in Their Selling," which reports the successful methods employed by eleven salesmen who tell how they get more value out of their companies' advertising.



You'll find represented many interesting variations in how they do this. Some are very ingenious; all are effective. You can be sure that more of your salesmen will use your advertising after they read how others get business through these simple methods.

The coupon is for your convenience in sending for your free copy. Then, if you decide you want to provide your salesmen with additional copies, they are available from NBP Headquarters in Washington, at twenty-five cents each. Or, if you choose you can reprint the material yourself and distribute it as widely as you please. But first, send for your free copy.

NATIONAL BUSINESS PUBLICATIONS, INC.
Department 2E
1413 K Street, N. W.
Washington 5, D. C. STerling 3-7533

Please send me a free copy of the NBP booklet "How Salesmen Use Advertising in Their Selling."

Name _____

Title _____

Company _____

Street Address _____

City _____ Zone _____ State _____

National Business Publications, Inc.

NBP

. . . each of which serves a specialized market in a specific industry, trade or profession.

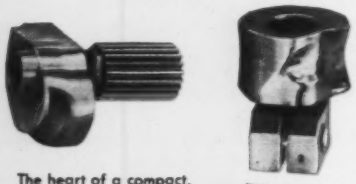
PRECISION
CAMS

PACK *Automation*
INTO INCHES!

to perform superhuman control functions, Parker 2 and 3 Dimensional Cams are used in Jet Aircraft, Missiles, Rockets, Instrumentation, wherever environmental extremes make precision mechanical control a functional asset.

2 DIMENSIONAL *Precision* CAMS

3 DIMENSIONAL *Precision* CAMS



The heart of a compact, automatic analog computer.

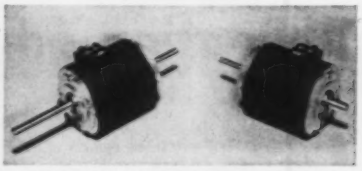
THE PARKER-
HARTFORD CORPORATION
Dept. M, Cam Division
Franklin Avenue, Hartford, Connecticut

☐ Please send "3 DIMENSIONAL CAMS" by return mail

☐ Please send "Design & Development" Bulletins on 2 and 3 Dimensional Cams

NAME.....
TITLE.....
COMPANY.....
ADDRESS.....
CITY..... ZONE.... STATE.....

Circle 536 on Page 19



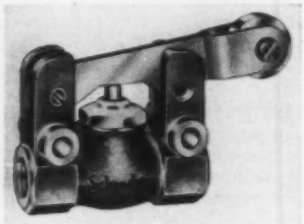
and other applications requiring minimum torque and miniature size. Clutch is magnetically set, with spring-set brake incorporating fail-safe brake design. Torque range of clutch is 100 oz-in., of the brake, 8 oz-in. Unit is designed for fast engagement and release and is furnished with drive and driven shafts. It weighs 15¼ oz and can be wound for any dc voltage up to 28 v dc. **Stearns Electric Corp.**, 120 N. Broadway, Milwaukee 2, Wis. K

Circle 885 on Page 19

Poppet-Type Valves

for all types of air controls

New two and three-way poppet-type valves have brass bodies with ¼-in. inlet and outlet ports. In-line mounting holes and interchangeable actuating levers facilitate application to all types of air controls. Valves have a 70 cfm airflow capacity, and are available



with roller (shown), solid angle, hand, and hand lockdown lever action. **A. Schrader's Son, Div., Scovill Mfg. Co. Inc.**, 470 Vanderbilt Ave., Brooklyn 38, N. Y. C

Circle 886 on Page 19

General-Purpose Relays

have high contact reliability

Frame 214 relays combine excellent contact reliability with small size and light weight. Use of Grade 5 melamine-bonded glass-fiber insulation for contact supports assures high contact stability with safeguard against failure resulting from

DEFIES HEAT
ABRASION...
FATIGUE...
LEAKS
FLEXIBLE TUBING FOR INDUSTRY
High temperatures and pressures? Exposure to crushing, abrasion, expansion, contraction? Name your operating conditions for air, water, steam lines, for conveying volatiles, gases, chemicals, powder, granular and semi-solid materials. Penflex can meet them with flexible bronze, galvanized and stainless steel corrugated and interlocked tubing. All types, all sizes. 1/8" to 24" I. D. Ask for booklet. Pennsylvania Flexible Metallic Tubing Company, Inc. 7239 Powers Lane, Phila. 42.
PENFLEX
TIGHT AS A PIPE BUT...
FLEXIBLE

Circle 537 on Page 19

Webster

NEW HIGH CAPACITY FLOW DIVIDER

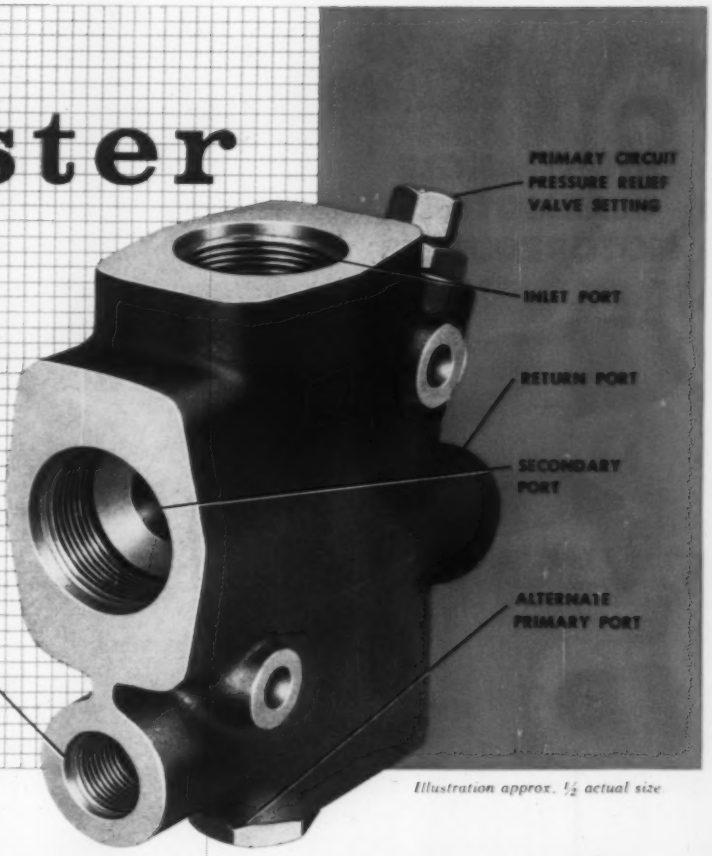


Illustration approx. ½ actual size

It could have been designed to your exact specifications

Webster's high capacity (60 gpm) flow divider is that versatile. Here's standard design that gives you a free hand in planning your hydraulic circuits — and adapts so easily and economically to your product and the job. With its small size (approx. 6½" x 5⅜" x 2½"), it fits easily in remote locations, tight quarters.

The new flow divider — operating up to 2000 psi — completely eliminates the need for a second pump. It supplies two hydraulic circuits, such as power lift and power steering, and permits each to be operated *simultaneously* at different pressures from *one single pump!* It also has a built-in relief valve on the constant flow section.

Could you use this new Webster flow divider on your product? Benefits like these add up to big dollars, better performance. Write for additional information.

call the man from Webster

OIL HYDRAULICS DIVISION

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Title .....

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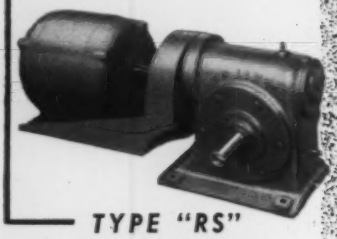
(Advertisement)

D.O.James
Established 1888

RIGHT ANGLE GEARMOTORS MOTOREDUCERS

TYPE "R"

RIGHT ANGLE GEARMOTOR — Horizontal or Vertical Drive, 8 sizes, ratio 6:1 to 100:1, ⅓ to 30 horsepower.



TYPE "RS"

RIGHT ANGLE MOTOREDUCER— Horizontal or Vertical Drive, 8 sizes, ratio 6:1 to 100:1, ⅓ to 30 horsepower.

OUR 70th YEAR

THESE D.O.James Right Angle Gearmotors and Motoreducers are of the same construction and high quality as the individual Gear Speed Reducers which we have been producing for so many years. They cover a very wide range of ratios, horsepowers, and are an ideal, compact, efficient unit for many power and space-saving installations.

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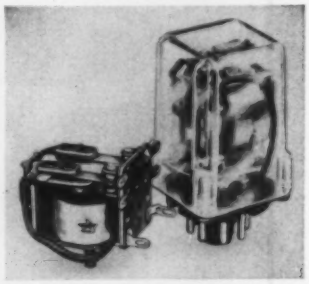
Circle 539 on Page 19

temperature and humidity changes. Wide hinge maintains accurate contact alignment. Relays are available in SPDT, DPDT, and 3PDT types. Contacts are rated 5 amp at



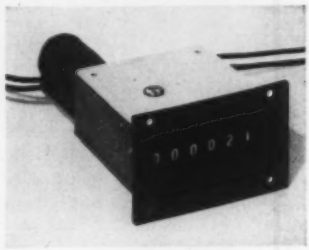
115 v ac, and coils to 115 v ac and dc. Open and plastic-enclosed types are supplied. **Struthers-Dunn Inc.**, Lambs Road, Pitman, N. J. E

Circle 887 on Page 19

Electrical Counters

have rated speed of 3000 counts per minute

No. 1591 panel-mounted, high-speed electrical counters are for use in industrial, data processing, and scientific applications. Rated speed is 3000 counts per minute. Instant reset is achieved in both electrically and manually reset types. Small panel size permits multiple installa-



tions in small panel area. Full range of dc voltages is available for both counter and reset operation. Low-wattage coils are designed for continuous duty. **Veeder-Root Inc.**, Hartford 2, Conn. B

Circle 888 on Page 19

Adhesive

for bonding plastic laminate

Clair-Tact is a new, fast-drying adhesive for bonding plastic laminate. It needs no clamps, since pressing to obtain contact provides excellent, permanent bond. Adhesive has

COST REDUCTION PROGRAM CALLS FOR COLD HEADING

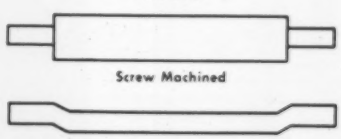
Hassall Re-Design Often Means Big Savings on Parts

The most important consideration we can point out to the designer or purchaser of fasteners and small parts is that any part which can be machined from rod stock is also potentially available from the cold heading manufacturer. This technique offers speed of production, without scrap loss, plus superior strength and appearance for low cost and high design efficiency.

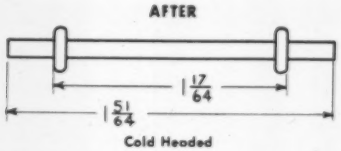
Perhaps our greatest contribution to your operation is our re-design service. An expert cold heading designer can very often study your drawings and come up with a modified part which will be lower in cost, stronger structurally, and easier for you to assemble.

This spacer is typical of such a Hassall re-design. Note the customer's drawing . . . this is a stamping, not too accurate, with poor bearing surfaces and not too easy to handle in assembly.

BEFORE



AFTER



Cold Headed

Now, look at this spacer as redesigned for cold heading. Now, a double collar spacer which is very accurate, structurally much stronger, and with much better bearing surfaces. And lower in cost!

Given complete specifications, including a drawing and an idea of the application, we can quickly tell you whether or not it will be advantageous to have your part or fastener JOB-DESIGNED by HASSALL.

Write today for your copy of our new Catalog No. 106.

John Hassall, Inc.
P. O. Box 2197
Westbury, Long Island, N. Y.
Manufacturers Since 1850

Circle 540 on Page 19

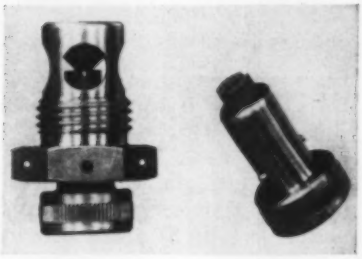
heat resistance above boiling point of water, and resists oil, grease, and water. Strength makes it suitable for edge gluing and bonding of sharply curved surfaces. **St. Clair Rubber Co.**, 440 E. Jefferson Ave., Detroit 26, Mich. H

Circle 889 on Page 19

Magnetic Drain Plug

has bayonet-type closure

New self-closing magnetic drain plug eliminates need for tools in maintenance inspection of gear cases and similar housings. It incorporates a knurled circular knob which, when pushed in and given a one-quarter turn, instantly removes



or inserts magnetic plug. When bayonet-type plug insert is removed, self-closing valve immediately seals off the opening to prevent loss of oil. Unit meets specifications for military and commercial aircraft. Particularly suitable for cold-weather operations, plug is useful in general industrial applications. **Technical Development Co.**, P. O. Box 82, Glenolden, Pa. E

Circle 890 on Page 19

Teflon Tape

for electrical insulation is 0.002 in. thick

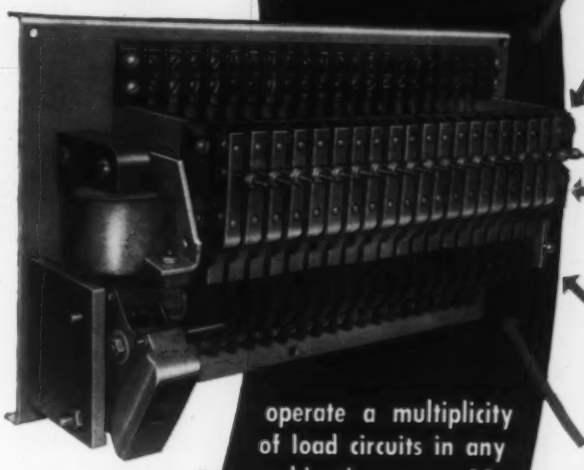
Temp-R-Tape C is a thermal-curing, pressure-sensitive Teflon tape for use as electrical insulation where a high dielectric, thin material is desirable. It provides 2750 v per mil dielectric strength and has operating temperature range of −100 to 500 F. Tape is 0.0015 in. cast Teflon film backing, with 0.005 in. thermal-curing, pressure-sensitive silicone polymer adhesive added. It has low moisture absorption and exhibits freedom from pinholes and voids. High elongation provides tight fit over sharp bends and compound surfaces. Applications include

A NEW APPROACH TO MACHINE PROCESS CONTROL

Step Sequencing

the new Eagle Step Switch

use any type of time or sensing device to advance the Eagle Step Switch



operate a multiplicity of load circuits in any combination up to 19 circuits

This new Eagle Step Switch also provides:

1 SEQUENCING INTERLOCK when used with multiple indexing circuits.

2 10 AMP SWITCH CONTACTS control load switches direct — no need for load relays.

3 MECHANICAL CIRCUIT INTERLOCK by cam action — eliminates interlocking relays.

4 115 VOLT COIL operates direct on AC with heavy duty ratchet mechanism — insures long life.

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Industrial Timers Division, Dept. MD-458
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Please send Bulletin 780 containing complete data on your new Eagle Step Switch.

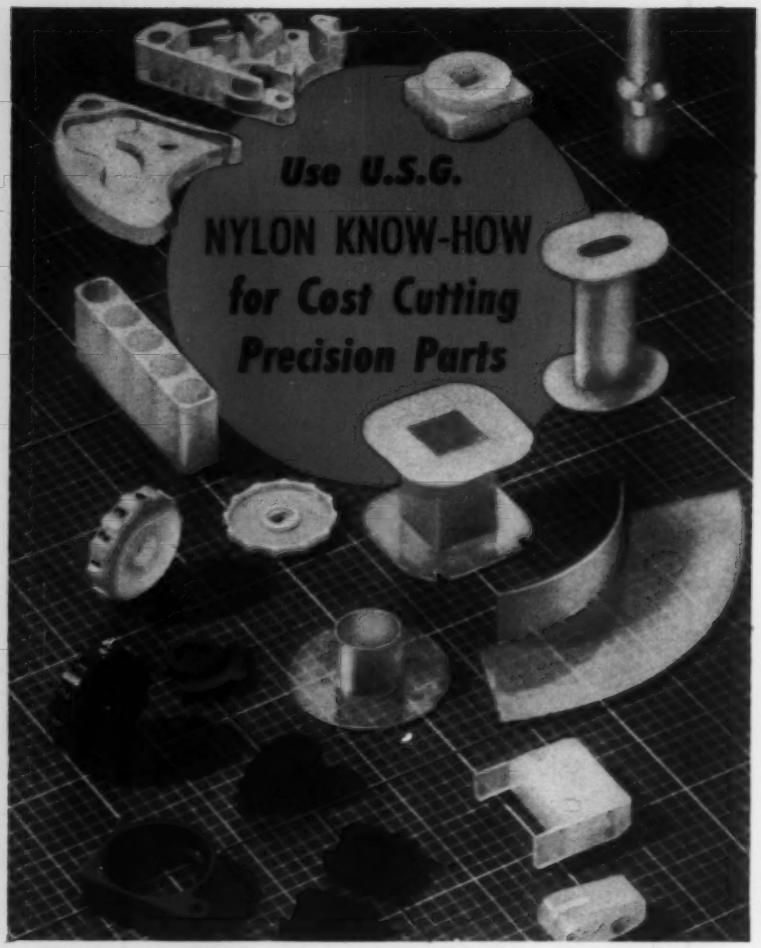
NAME AND TITLE

COMPANY

ADDRESS

CITY ZONE STATE

Circle 541 on Page 19



For those mechanical and electro-mechanical parts that must be strong, durable, wear resistant, *design to use Chemiseal Nylon* (du Pont ZYTEL). It has the highest compressive strength, is the most rigid, has the best resistance to heat, abrasion, chemicals, solvents, oils and greases—and is the lowest priced of the standard nylon compositions.

U.S.G. Nylon service goes all the way, offering STOCK (sheets, tape, rod, tubing, special shapes), for manufacture of parts in your own plant; MACHINING (precision fabrication on high speed automatics) to your specifications; and INJECTION MOLDING (volume production to close tolerances at lowest cost).

To be sure you are securing your parts at the lowest cost, consistent with your requirement at every stage from prototype to plant scale production—*check your costs with U.S.G. "know-how".*

For prompt service, contact one of The Garlock Packing Company's 30 sales offices and warehouses throughout the U.S. and Canada, or write

United States Gasket Company
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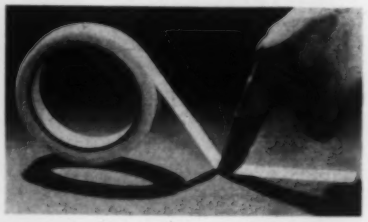
United States Gasket *Plastics Division of* **GARLOCK**



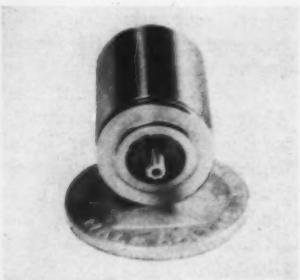
slot lining, interlayer and interphase insulation, coil wrapping, wire splicing, and harness bundling for Class H and higher temperature requirements. **Connecticut Hard Rubber Co.**, 407 East St., New Haven 9, Conn. B

Circle 891 on Page 19

Servomotors

achieve high torque-to-inertia ratio in short length

Size 8 servomotors are applicable in a variety of aircraft and missile applications. They achieve high torque-to-inertia ratio within a length of 1.062 in. and diameter of 0.750 in. Units are available with inputs from 6 to 57 v and operate



within ambient temperature range of −55 to 125 C. Motors, which weigh only 1.6 oz, meet MIL-E-5272A. **Induction Motors Corp.**, 570 Main St., Westbury, L. I., N. Y. D

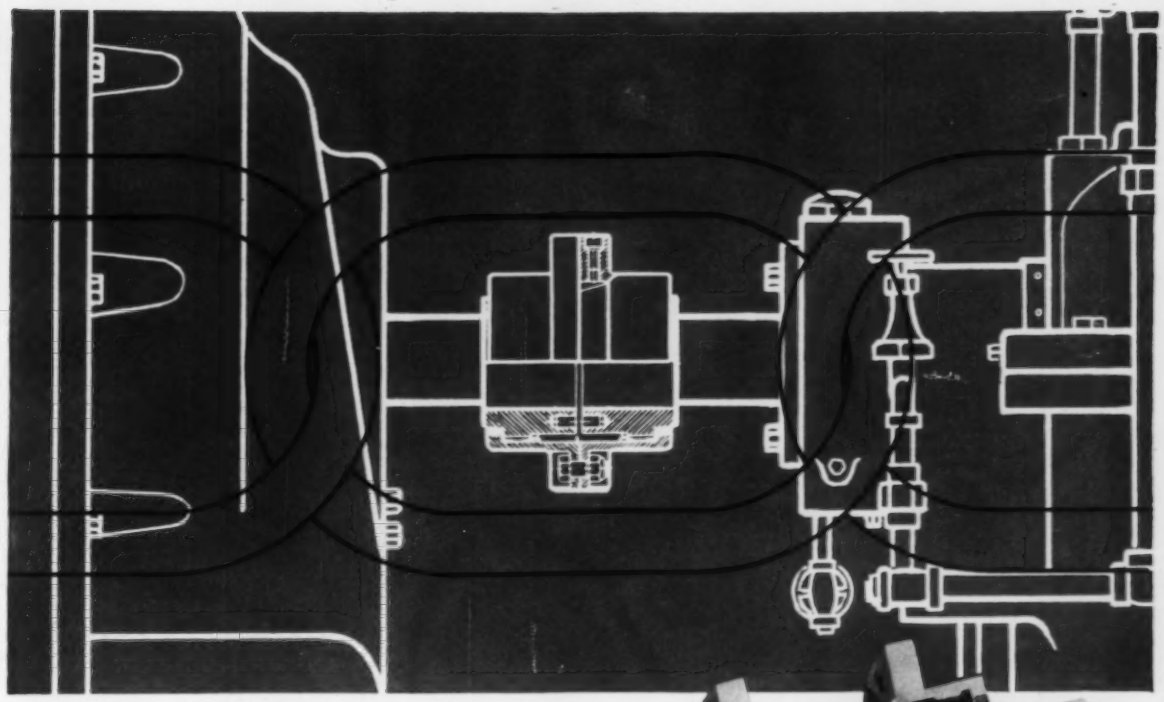
Circle 892 on Page 19

Swivel Joint

for steam pressures to 750 psi

Series 750 Type S swivel joint provides a pivot point in pipe hookups to make piping movable or flexible. It is for use with steam pressures to 750 psi and temperatures to 750 F. Sizes 1 and 1¼ in. are available from stock, with screwed or welding ends; other sizes are available to order. Casing and retainer flange are

Circle 542 on Page 19



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SPECIFY THIS

POWER LINK

When a lot of time and effort have gone into the design of a piece of driven equipment, it makes sense to pick the power link carefully. Take a pump or compressor, for instance. No matter how well it is designed and built, for long service life and operating efficiency, it needs protection against strains due to misalignment.

Waldron gear couplings provide complete protection and positive, trouble-free drive because

They are strong ... Hubs and cover sleeves for sizes 1¼A through 7A are machined from tough steel forgings. Hubs are keyed to the shafts. The two one-piece cover sleeves function as a single, rigid unit serving as a floating connecting link between the hubs. High strength of forgings makes possible a very compact coupling with low rotating inertia.

They are reliable ... There are no flexible parts to bend or break and the coupling is dust, moisture, and oil tight. Patented Walflex seal is at the lowest possible diameter where centrifugal force is least. Clearance between teeth in hubs and sleeve is engineered so that an oil wedge always separates them, taking the wear.

They are available ... Plenty of rough bore couplings, already assembled—on the shelf for *immediate* delivery. Finish bored standard couplings shipped to meet customers' schedules. We are geared up to give you realistic delivery on *any* type of couplings.

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Circle 543 on Page 19

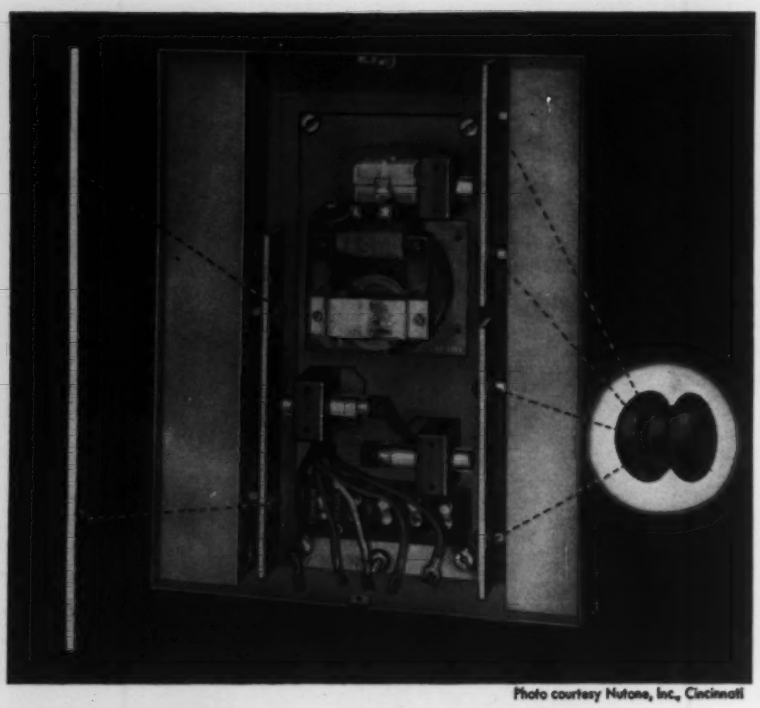

Photo courtesy Nutone, Inc., Cincinnati

Engineers Develop New Use for Rubber

Rubber, normally used to *reduce* vibration, now can be made to *increase* vibration

Here rubber grommets serve as mountings for the tone bars in Nutone Door Chimes. To obtain maximum tone quality and resonance required of these musical chimes, the grommets must vibrate compatibly with the tone bars . . . a truly *unusual assignment* for rubber.

Only by skillful compounding can rubber be diverted from its normal dampening characteristic and be given this vibrant quality. The slightest deadening effect would destroy the rich tones and kill the tone hang.

The successful development of this lively, age-resistant rubber stock typifies the complete engineering and laboratory—as well as manufacturing—skill available at Continental. Whenever you need "engineered rubber parts" — molded or extruded, natural or synthetic—call Continental, Specialists since 1903.

Engineering catalog.

In addition to custom-made parts, Continental offers an extensive line of standard grommets, bushings, bumpers, rings and extruded shapes. Hundreds of these are shown in the No. 100 Engineering Catalog. Send for a copy or refer to it in Sweet's Catalog for Product Designers.

Another achievement in **RUBBER**

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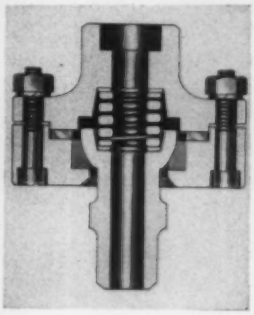
steel, ball is hardened steel, and spring is stainless steel. New 11CAS gasket is high-density carbon with relatively low coefficient of friction, and is lapped to the ball. Move-



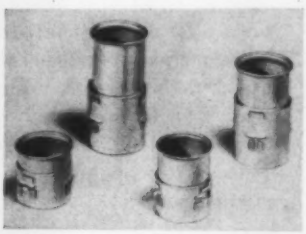
ment between ball and gasket provides constant relapping which automatically adjusts for wear. Gasket is installed under compression in retaining flange to prevent leakage. **Barco Mfg. Co.**, Dept. J-14, 500 N. Hough St., Barrington, Ill. J

Circle 893 on Page 19

Telescoping Shield

for miniature electron tubes

CapTiVated snap-in telescoping shield for miniature electron tubes is designed for use with printed-circuit boards. Shields provide compact printed circuitry in subdeck applications. Available in design configurations to meet standard and specialized chassis requirements,



snap-in shield eliminates staking, riveting, or soldering. It accommodates both seven and nine-pin miniature electron tubes. **Staver Co.**, 41-51 N. Saxon Ave., Bay Shore, L. I., N. Y. D

Circle 894 on Page 19

Multiconductor Cable

is lightweight and flexible

Polystrip is a lightweight, flexible multiconductor flat cable for use in

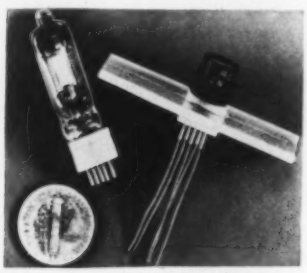
electrical and electronic equipment. Insulation is a special polyester which can be stripped quickly so that cable can be solder dipped. Rated at 85 C continuously, cable is available in widths up to 51 conductors. It consists of flat copper ribbon, 0.0015 in. thick and 0.030 in wide, encased in a plastic insulation with overall thickness of 0.009 in. Each conductor is rated at 1 amp in free air at 25 C. Positioning one conductor of a cable to a connector or printed-wiring board automatically prepositions remaining conductors. **International Resistance Co.**, 401 N. Broad St., Philadelphia, Pa. E

Circle 895 on Page 19

Transistor Socket

is Teflon insulated

Low-loss transistor socket withstands shock, vibration, and high temperatures. Teflon insulated, unit is for missile guidance and military electronics, and for subminia-



ture tubes with in-line leads. It is also applicable to printed circuits. **Fluorocarbon Products Inc., Div., U. S. Gasket Co.**, 602 N. Tenth St., Camden, N. J. E

Circle 896 on Page 19

Ball Bearings

have fractured outer ring to permit use of extra balls

Midget T ball bearings have high ratio of load capacity to unit volume of bearing, and low starting and running torque. Outer ring is fractured to permit introduction of extra balls, maintaining maximum ball complements without loading notches. Use of a light, one-piece retainer is made possible. Four sizes of the bearings available are $\frac{3}{8}$, $\frac{1}{2}$, $\frac{5}{8}$, and $\frac{3}{4}$ in., with corresponding ODs $\frac{1}{4}$ in. greater. Cross-sec-

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HILLIARD
Over-Running
CLUTCHES

1 LONG LIFE because the rolls have no localized wear points.

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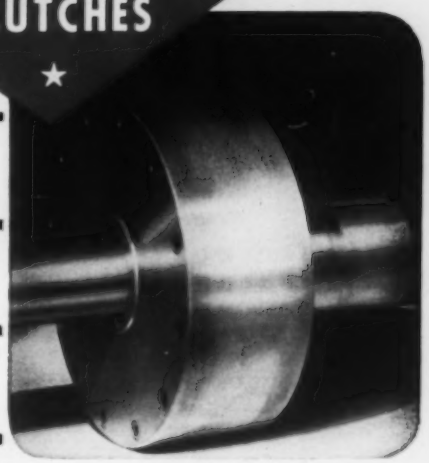
3 ACCURATE because of individual spring pressure on each roll.

4 RENEWABLE CAM SURFACES for increased life without machining or new parts.



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HILLIARD - TWIFLEX CENTRIFUGAL COUPLING for smooth, easy starting of any load automatically with overload protection and ability to accommodate shaft misalignment. Ask for Bulletin CE-3.

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Circle 545 on Page 19

DURAKOOL Tilt Switches are the Life of your Automatic Controls

MILLIONS OF CYCLES WITHOUT FALTERING

This steel-clad Durakool mercury tilt switch has unique construction features that deliver years of trouble-free performance on the most difficult assignments you can find. Operating under sealed-in, pressurized hydrogen gas, it takes 24 hours, fast cycling schedules in stride. 7 sizes, 1 to 65 amperes. Send for Bulletin 525.

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Durakool ALL-STEEL MERCURY *Switches*

Circle 546 on Page 19

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Division of F. W. Dodge Corp., 119 W. 40th St., New York 18, N. Y

Circle 547 on Page 19

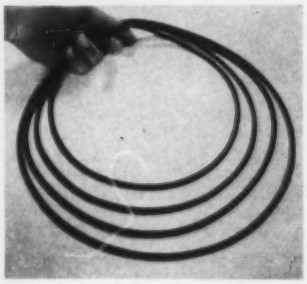
tion from bore to OD measures only 1/8 in. Standard material is 440C stainless steel for rings and balls, with one-piece retainer of machined phenolic. Applications include instruments, missile and rocket components, electromechanical devices, radar and microwave equipment, food-processing machinery, and cameras. **Split Ballbearing Div., MPB Inc.**, Lebanon, N. H. B

Circle 897 on Page 19

Lathe-Cut Rings

for sealing applications

Lathe-cut, synthetic-rubber, rectangular cross-section rings are available in various O-ring compounds. Rings are economically produced to dimensional accuracy with-



in close tolerances, making them suitable for many gasket applications. **Parker Rubber Div., Parker-Hannifin Corp.**, 17325 Euclid Ave., Cleveland 12, Ohio. F

Circle 898 on Page 19

Potentiometer

has power rating of 2 w at 150 C

Resistance element of new precision potentiometer is made of alloys evaporated in high vacuum and deposited onto a ceramic disc. Metal Is deposited in coatings, and thickness of coatings can be controlled to produce desired electrical characteristics. Unit withstands extreme vibration, shock, and humidity.

Brighter picture, greater contrast. Even this dimly illuminated underwater scene "gains" depth and detail when pictured on monitor (inset) of super-sensitive new TV camera made with nickel-containing metal shield.

How nickel sharpens the "eye" of the military's new underwater TV camera

At the bottom of the ocean, it is hard enough to see with your naked eye.

For the "eye" of a TV camera—the image orthicon — it was out of the question . . . until Admiral Corporation put its designers to work on an extra sensitive instrument for the Armed Forces.

They worked out a special system of circuits that "magnify" the light the camera receives. But stray magnetic fields set up by these circuits wandered, interfering with the camera's operation.

To overcome this interference, Admiral's engineers built a shield of a special nickel alloy called MuMetal* around the image orthicon. This alloy, (77% nickel), possesses high magnetic permeability. In effect, it provides a magnetic path-of-least-resistance which detours these stray fields away from vital parts of the equipment.

The result is a TV camera that can "see" as much by the flicker of a match as a man with 20/20 vision sees by the light of a 150-watt bulb!

And because the camera must be able to operate under water, it has nickel-plated hardware to provide corrosion resistance. And nickel-containing stainless steel hardware where mechanical strength is needed.

Do you have a metal problem? One that involves magnetism . . . shielding . . . corrosion . . . high or low temperatures . . . fatigue or some other complicating factor? Talk it over with us. We – and nickel – may be able to offer constructive help.

*Trademark, Allegheny Ludlum Steel Corporation

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street INCO New York 5, N. Y.

INCO NICKEL

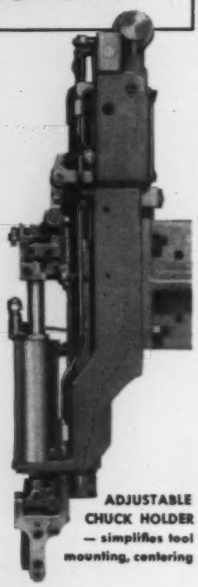
NICKEL ALLOYS PERFORM BETTER LONGER

SAVE TIME AUTOMATING SMALL PARTS ASSEMBLY OPERATIONS

SPECIFY

DIXON

"Auto-Positioner"



FITS IN SMALL SPACE—21" X 3¼" X 5" DEEP

SEE AT DESIGN ENG. SHOW BOOTH-634

ADJUSTABLE CHUCK HOLDER — simplifies tool mounting, centering

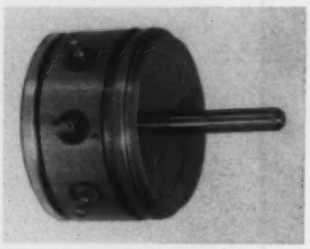
- **STANDARD HEAD DESIGN**—Saves engineering time. Easy to apply to variety of jobs. Operates on ordinary 80# air pressure, 110 volts. Has machined T-slot surface, simple adjustments. Tooling, mounting column, feeders, etc., optional.
- **BUILT-IN SENSING**—Acts as automatic inspector, assures quality production. Machine stops if part is missing or malformed.
- **FAST, VERSATILE**—Handles wide range of feedable metal or plastic parts from 1/16" to 3" O.D. at speeds up to 100 cycles per minute. Easy to tool.
- **PRECISION-BUILT**—Sturdy frame, one-piece super-finished piston and rod, cushioned air cylinder, J.I.C. controls.
- **WRITE FOR FULL DATA**—New circular gives complete specifications, shows typical applications.

DIXON PARTS ESCAPEMENTS Releases single parts or in multiples at speeds up to 200 per minute. Standard models available for air, solenoid, or mechanical operation.

DIXON AUTOMATIC TOOL, Inc.
2310–23 rd AVENUE
ROCKFORD, ILLINOIS

Equipment for Automatic Parts Handling and Assembly

Circle 548 on Page 19



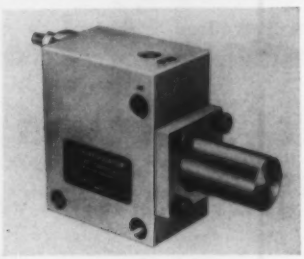
Power rating is 2 w at 150 C. Units with diameters from ½ to 3 in. are available. Two or more independent sections can be ganged on a common shaft as required. **Servomechanisms Inc.**, 12500 Aviation Blvd., Hawthorne, Calif. L

Circle 899 on Page 19

Flow Regulator

incorporates built-in relief valve

Combination bypass and restrictor-type flow regulator, incorporating a built-in relief valve, can be used as a high-capacity relief valve, as a remotely operated relief valve, to replace a pump for power steering, or to provide small flow for a control system. Port connections are designed for ½, ¾, or 1-in. pipe. Maximum operating pressure is



3000 psi, and relief valve is adjustable within 100 to 800, 250 to 1500, and 500 to 3000-psi ranges. **Fluid Controls Inc.**, 1284 N. Center St., Mentor, Ohio. F

Circle 900 on Page 19

Pillow Block

for shaft sizes from ½ through 1 in.

New pillow block combines a strap-type housing with rubber isolated sleeve-bearing cartridge. Available with either double-lubricating graphited bearing or sintered bearing, unit is for shaft sizes from ½ through 1 in. Housing is 16 gage steel, and all steel parts are cadmi-

For LINEAR AND ROTARY POSITIONING

Specify LimiTorque ACTUATORS

LimiTorque actuators are efficient, sensitive, automatic heavy duty power-operated units for *positioning machine parts or other assemblies requiring Linear or Rotary Motion.*

LimiTorque is an electro-mechanical mechanism, using motor power through highly efficient and precision gearing, to impart Linear or Rotary motion . . . Limit switches are available to limit the travel in either direction—Thrust and Torque responsive switches control thrust or provide emergency shut-off. With LimiTorque it is possible to control full travel accuracy to within .2%—LimiTorque is easily and accurately controlled by the mere "push of a button".

LIMITORQUE IS BACKED BY 30 YEARS' EXPERIENCE IN MOTORIZING ALL TYPES OF VALVES—WHY NOT CONSULT US REGARDING ANY PROBLEM YOU MAY HAVE INVOLVING LINEAR ACTUATION; OUR ENGINEERS CAN NO DOUBT HELP YOU SOLVE THAT PROBLEM.

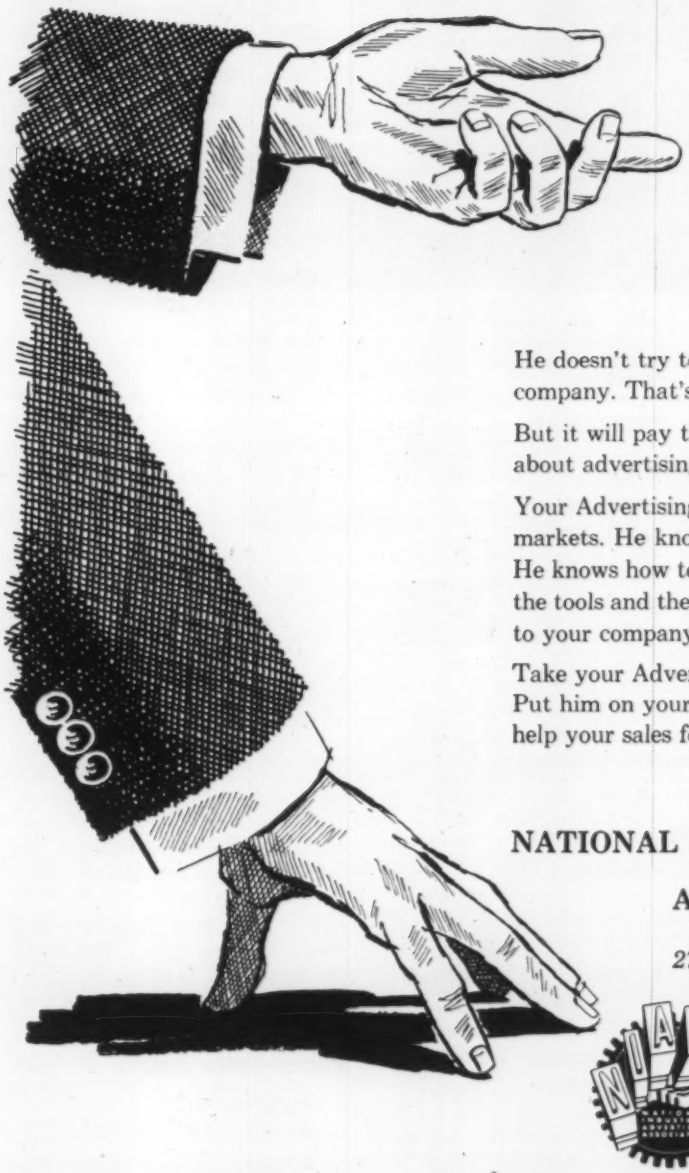
LimiTorque

PHILADELPHIA GEAR WORKS, INC.
ERIE AVE. & G STREET, PHILADELPHIA 34, PENNA
Offices in all Principal Cities

INDUSTRIAL GEARS & SPEED REDUCERS
LIMITORQUE VALVE CONTROLS
FLUID MIXERS • FLEXIBLE COUPLINGS

Circle 549 on Page 19

Does your Board of Directors listen to this man?



He doesn't try to tell your Directors how to run the company. That's their job, and he respects it.

But it will pay them to listen to him when he talks about advertising for your company. That's his job!

Your Advertising Manager is a man who knows markets. He knows the science of "mechanized selling." He knows how to help turn sales goals into sales. He has the tools and the know-how to make major contributions to your company's progress and profit.

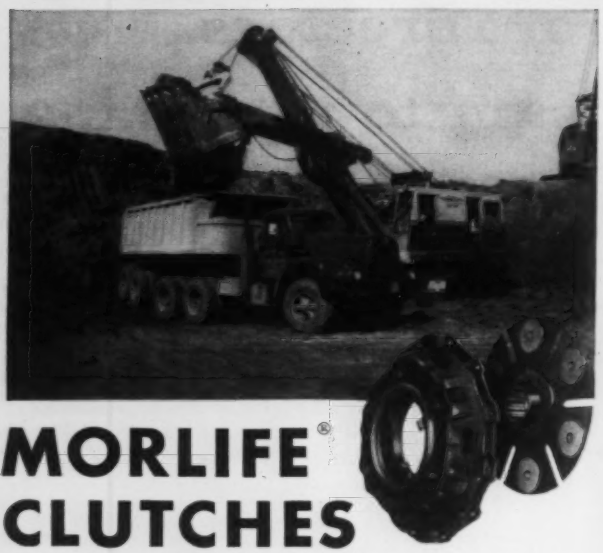
Take your Advertising Manager into your confidence. Put him on your first team. Let him manage. He can help your sales force sell more economically.

NATIONAL INDUSTRIAL ADVERTISERS ASSOCIATION, INC.

271 Madison Avenue, New York 16, N. Y.

An organization of over 4000 members engaged in the advertising and marketing of industrial products, with local chapters in ALBANY, BALTIMORE, BOSTON, BUFFALO, CHICAGO, CLEVELAND, COLUMBUS, DALLAS-FORT WORTH, DENVER, DETROIT, HAMILTON, ONT., HARTFORD, HOUSTON, INDIANAPOLIS, LOS ANGELES, MILWAUKEE, MINNEAPOLIS-ST. PAUL, MONTREAL, QUE., NEWARK, NEW YORK, PHILADELPHIA, PITTSBURGH, PORTLAND, ROCHESTER, ROCKFORD, ST. LOUIS, SAN FRANCISCO, TORONTO, ONT., YOUNGSTOWN.

ROCKFORD



Small Spring Loaded

Automotive Spring Loaded

Heavy Duty Spring Loaded

Oil or Dry Multiple Disc

Heavy Duty Over Center

Light Over Center

Power Take-Offs

Speed Reducers

MORLIFE® CLUTCHES

Reduce the Effect of Centrifugal Force Developed by High-Speed Engines

Because ROCKFORD Morlife Clutches handle double the amount of torque handled by ordinary friction clutches, they enable design engineers to reduce the effect of centrifugal force developed by modern, high-speed engines. By cutting down the required diameter of the clutch, they reduce weight. By insuring better heat disposal, they multiply the clutch's work-life. While your next model is in the planning stage, it will pay you to investigate how this new type clutch will improve the operation and eliminate 90% of the clutch service requirements of *your* product.

SEND FOR THIS HANDY BULLETIN

Shows typical installations of ROCKFORD CLUTCHES and POWER TAKE-OFFS. Contains diagrams of unique applications. Furnishes capacity tables, dimensions and complete specifications.

ROCKFORD Clutch Division BORG-WARNER

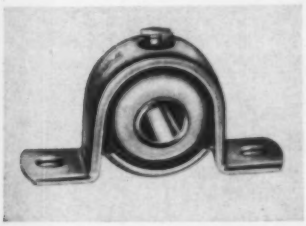
311 Catherine St., Rockford, Ill., U.S.A.

Export Sales Borg-Warner International — 36 So. Wabash, Chicago 3, Ill.

ROCKFORD B-W BORG-WARNER

CLUTCHES

um plated to resist corrosion. Unit is 4 in. long, 2 in. high, 1⅛ in. wide and can be mounted on hole centers from 3 to 3¼ in. using 5/16-



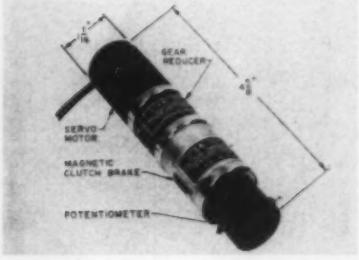
in. bolts. Shaft-center height is 1 in. **Randall Graphite Bearings Inc.**, Greenlawn and Lake Streets, Lima, Ohio. G

Circle 901 on Page 19

Servo Package

contains motor, clutch-brake, reducer, and potentiometer

Model T-950 compact servo package combines a servo motor, geared reducer, magnetic clutch-brake, and potentiometer. Motor drives potentiometer arm at a speed of approximately 40 rpm. Upon a given signal, motor is uncoupled and potentiometer is braked within two



millisec. Using the same basic units, various combinations of operational requirements can be accomplished. **Sterling Precision Corp.**, 34-17 Lawrence St., Flushing 54, N. Y. D

Circle 902 on Page 19

Repeat-Cycle Timers

miniature units have up to ten switches

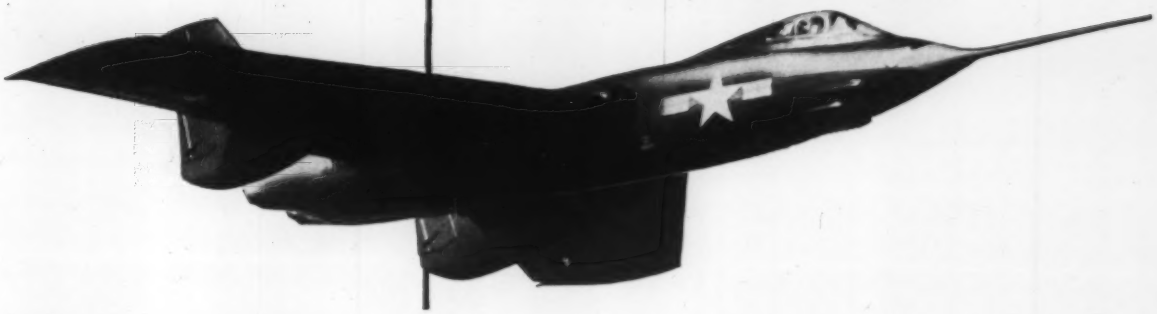
Subminiature, hermetically sealed repeat-cycle timers, designed specifically for aircraft, missile, and rocket applications, have industrial applications where space and weight are at a premium. They are available with a variety of motors and

Circle 551 on Page 19

For your selection

ALTEMP

HIGH TEMPERATURE SUPER ALLOY STEELS



ALTEMP A-286 . . . an austenitic iron-nickel-chromium alloy made heat-treatable by the addition of titanium. Designed to maintain high strength and corrosion-resistance up to the 1350 F range, and to afford satisfactory scale resistance up to 1800 F.

A-286 was developed in the A-L Research Laboratory in Watervliet, N.Y., in the 1949-51 period. Among the high-strength, heat-resisting alloys, it has exceptionally low strategic alloy content, improved hot-working and machining qualities, and good center ductility in large sections. Currently used in jet engines and superchargers for such applications as turbine wheels and blades, frames, casings, afterburner parts, bolting, etc.

This alloy is readily produced in large quantities without the need of special steel-making equipment. It is available in the form of billets, bars, forgings, sheet, strip, tubing and hot-extruded shapes.

ALTEMP S-816 . . . a chromium-nickel-cobalt base alloy, strengthened by additions of molybdenum and tungsten, and with a columbium-carbon ratio of ten to one to insure its structural stability. Designed for high strength and corrosion-resistance service in the 1200-1500 F range, and at higher temperatures under lower stress conditions. Developed in the A-L Research Laboratory at Watervliet, N.Y. in the years of 1940-43, and engine-tested and proved for periods of over 30,000 hours.

S-816 is used currently for turbine blades in two of the production jet engines, also in a number of experimental aircraft and commercial gas turbines. Except for seamless drawn tubing, it is available in practically all forms and shapes in which stainless steels are processed, including hot extrusions.

ALTEMP S-590 was designed for service in the range of 1100-1400 F temperatures where high strength and corrosion resistance are required, and where cost is also a factor. Unlike S-816, which is practically a non-ferrous alloy, S-590 has a chromium-nickel-cobalt-iron base. However, it employs the same molybdenum and tungsten additives, and the same columbium-carbon ratio.

S-590 was developed at the Watervliet Laboratory and field-proved during the same years as S-816. It is available in the same shapes and forms, and is currently being used for turbine blades and wheels in experimental commercial gas turbines.

OTHER GRADES . . . among the many other Super Alloys made by Allegheny Ludlum are V-36, M-252, 19-9 DL, 19-9 DX and Waspaloy.

Do you have a high temperature problem? The services and experience of our Research Laboratories and Technical Staff are completely at your command. ***Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pa.***

WSW 8310 B

WRITE FOR INFORMATION

Certified laboratory data on the properties of Allegheny Ludlum high temperature Super Alloy Steels are yours on request.

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Allegheny Ludlum

Stocks of AL Stainless Steels carried by all Ryerson warehouses

AL® LEADING PRODUCER HIGH-ALLOY STEELS

Circle 552 on Page 19

Actual size photos
Open type
Enclosed in clear plastic with octal style base

HERE'S REAL CONTACT **RELIABILITY** IN

Small, low cost, General Purpose Relays

These new Struthers-Dunn 214 Frame Relays handle any general purpose application within their rating — *and do it at materially lower cost, in less space, with less weight.*

Maximum contact reliability is a prime feature of their design. Grade G-5 melamine bonded fibre glass insulation insures exceptional firm contact support with adequate protection against temperature and humidity changes. A wide hinge maintains accurate contact alignment and increases operating life.

AVAILABLE FOR **PROMPT DELIVERY** FROM **STOCK**

CONTACT TYPES: SPDT, DPDT and 3PDT

CONTACT RATING: 5 amps. at 115V AC

COILS: to 115V AC and DC

SD Data Bulletin 2214 on request

S-D **STRUTHERS-DUNN, Inc.**
Pitman, N. J.

Makers of the world's largest selection of relay types

Sales Engineering Offices in: Atlanta • Boston • Buffalo • Chicago • Cincinnati Cleveland • Dallas • Dayton • Detroit • Kansas City • Los Angeles • Montreal • New Orleans • New York • Pittsburgh • St. Louis • San Francisco • Seattle • Toronto

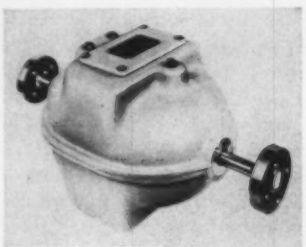
up to ten switches. The 4400 series is used for direct-current timers, and cycling times from 5 sec to 25 min can be supplied. The 25400 series is used for 400-cycle units. Timing accuracy is determined by type of motor used and environmental conditions encountered. Timers meet applicable military specifications and can be supplied with radio interference filtering for dc units. **A. W. Haydon Co.**, 232 N. Elm St., Waterbury, Conn. B

Circle 903 on Page 19

Flow Meter

for ½-in. flow lines

Magnetic flow meter, available for ½-in. flow lines, is useful in ratio flow control systems where small flows are ratioed to larger ones. Meter provides accuracy of 1 per cent of full scale throughout entire scale, and is unaffected by



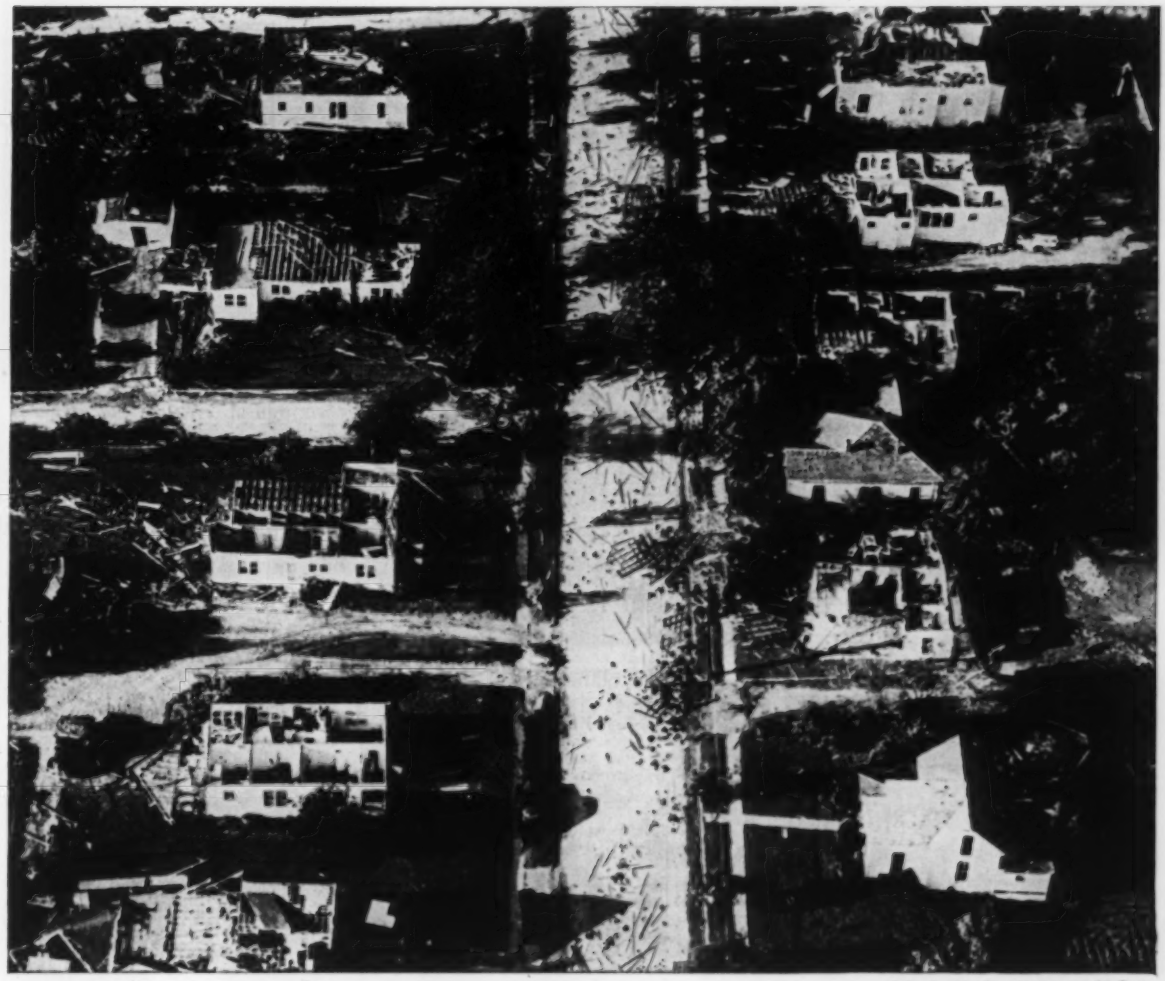
pressure, viscosity, density, or changes in conductivity of flowing liquid. Flow rates as low as 3 gpm can be measured. **Foxboro Co.**, Foxboro, Mass. B

Circle 904 on Page 19

Transistor

is composite germanium-silicon unit

Composite germanium-silicon NPN power transistor, No. 25N, features high gain and is thermally compensated to prevent adverse thermal runaway effects under load. Unit is suitable for linear amplifiers and nonlinear switching applications



Maple St., Small Town, U.S.A.

A TOWN WHERE "NOTHING EVER HAPPENS"...

A home town—like your town. A place where people said "it couldn't happen to us."

But it *did*. Like a whip, a great tornado lashed down Maple Street, splintering houses, leaving people hurt—homeless—panic-stricken.

A desperate call went out for the Red Cross and quickly, automatically, the team went into action.

Red Cross nurses slipped into uniform . . . volunteers set up first aid stations . . . canteens fed the hungry. Later, Red Cross money and work helped rebuild the town.

Last year was one of the worst disaster years of this century, and the year before, 1956, was almost as bad. Every month and in every state, the Red Cross strained to the limit as hurricanes, floods, tornadoes, forest fires swept across the country.

Red Cross receives no government funds—depends entirely upon *you* for support. Give as much as you can. Your dollars may go to your own town when it needs them most.

Join and Serve

SPACE CONTRIBUTED BY MACHINE DESIGN

rule of thumb is out!

NOW

for the first time a technical handbook on GRAY AND DUCTILE IRON CASTINGS

with hundreds of ideas for improving methods of designing, specifying and applying castings!

620 pgs.; 415 illustrations; $10.00

Looking for new ways to reduce manufacturing costs? Send for this comprehensive gray and ductile iron castings guidebook. Gaining one idea on how to improve your methods of designing, purchasing or applying gray, ductile, white and high alloy iron castings will mean more to you in actual dollars and cents than many times your original investment. This indispensable reference, just off the press, was compiled with the help of scores of outstanding authorities under the sponsorship of the Gray Iron Founders' Society. Mail coupon now for free 10 days examination!

CHECK THESE PARTIAL CONTENTS

1. **Design.** Type of Castings—Design Sequence—Designing for Function, Strength, Performance, Appearance, Producibility—Soundness of Castings—Factors Affecting Costs—Tolerances.

2. **Specifying and Purchasing.** Kinds of Foundries—Casting Processes—Types of Patterns, Core Boxes, Cast Iron—Cost Factors—Delivery Schedule—Inspection Methods.

3. **Properties of Gray Iron.** Transverse Fatigue, Acoustic Properties—Stress-Strain Characteristics—Tensile, Compressive, Torsional and Shear Strengths—Hardness—Impact Resistance—Damping Capacity.

4. **Properties of Ductile Iron.** Heat Treatment—Tensile and Impact Properties—Hardness — Ductility — Elasticity — Compressive Strength — Endurance Limit — Elevated Temperature Properties.

5. **White and High Alloy Cast Irons.** High Silicon Irons — High Chromium Irons — High Nickel Irons—Special Purpose Alloy Cast Iron — High Alloy Ductile Irons.

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NEW 620 Page Handbook

To help you design successfully and economically, the Gray Iron Founders' Society has compiled this 620-page handbook. Just off the press, this valuable reference has hundreds of suggestions on how to improve products and cut manufacturing costs. Covers 263 subjects on properly designing, purchasing and applying gray and ductile iron castings.

GRAY IRON FOUNDERS' SOCIETY, INC.
National City-East Sixth Building,
Cleveland 14, Ohio

Please send me a copy of the new Gray Iron Castings Handbook for 10 days free examination. Within 10 days I will send you $10.

☐ $10 enclosed ☐ Purchase Order enclosed ☐ Bill me

Name_____

Company_____

Address_____

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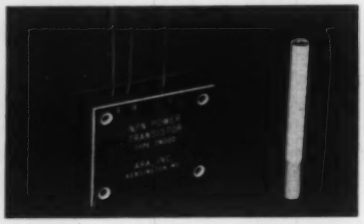
GRAY IRON FOUNDERS' SOCIETY, INC.



from dc to alpha cutoff frequencies, and where high-impedance driving sources exist in common emitter, common base, and common collector configurations. It has general characteristics of a small signal transistor at input, power transistor at output, and overall gain of a cascaded amplifier. Maximum junction temperature is 100 C. **Semiconductor Div., Advanced Research Associates Inc.**, P. O. Box 68, Kensington, Md. C

Circle 905 on Page 19

Water-Resistant Adhesive

for bonding labels on container surfaces

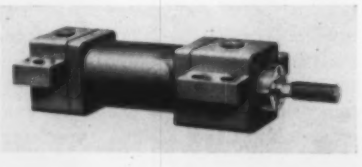
Water-resistant, colorless adhesive, designated EC-1341, exceeds requirements of MIL-A-3941 for bonding and protecting labels on a variety of container surfaces of fiberboard, wood, steel, and galvanized iron. After label has been bonded to surface, another coat is brushed over label, insuring protection against abrasion, marring, and corrosion. Adhesive has excellent resistance to fresh and salt water, temperature extremes, and oil. It retains strength at temperatures to 150 F. **Adhesives, Coatings & Sealers Div., Minnesota Mining & Mfg. Co.**, 411 Piquette Ave., Detroit 2, Mich. H

Circle 906 on Page 19

Double-Acting Cylinders

in eight sizes from 2 to 8 in.

New 2000-psi, double-acting hydraulic cylinders have interchangeable foot lug, center lug, front flange, rear flange, and clevis-



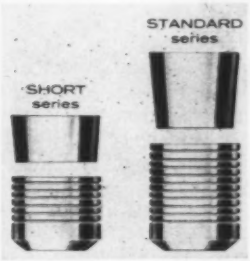
mounting steel and heads. Cylinders are available in eight sizes from 2 to 8 in. with standard or large rams, with strokes to 160 in., and with dashpot cushions for either or both end heads. Keepering construction permits end heads to be rotated for multiple piping positions, and for independent head disassembly. **Oilgear Co.**, 1560 W. Pierce St., Milwaukee 4, Wis. K

Circle 907 on Page 19

Pin Plugs

in new short type

New short series of pin plugs is recommended as a substitute for standard sizes when space is at a premium. Shorter plugs seal drilled holes dry under pressures to 10,000 psi or higher, depending on



size and material. They are available in both aluminum and stainless steel, and include a size for holes only 0.06 in. in diam. **Lee Co.**, P. O. Box 418, Westbrook, Conn. B

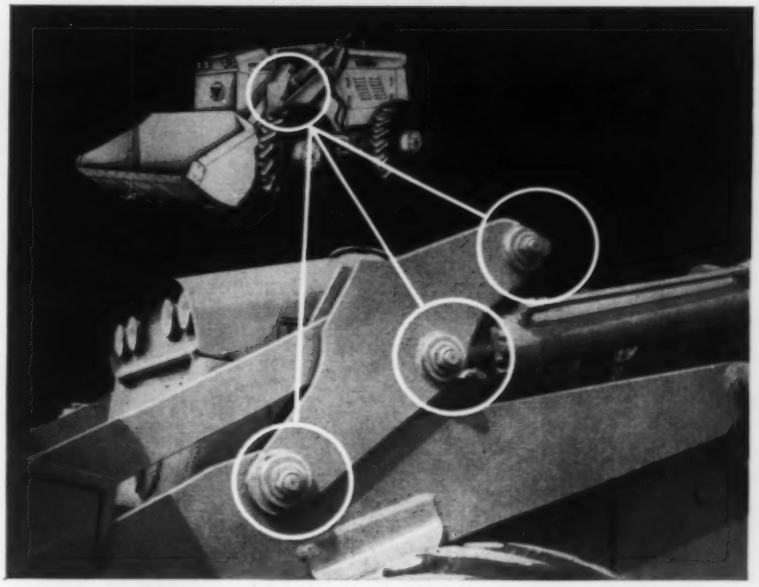
Circle 908 on Page 19

Acceleration Switch

has adjustable acceleration setting

Model 117 SPST acceleration switch has omnidirectional sensitivity in a single plane, adjustable acceleration setting, and large current capacity. Upon reaching preset acceleration level in plane of sensitivity, switch trips and locks in a closed position regardless of subsequent accelerations. Reset button permits switch to be returned to open position. Small size and light weight make unit suitable for aircraft use in applications such as emergency-exit lighting, destruction of classified equipment, and actuation of fire extinguishers upon crash. Other uses include arming devices on missiles,

FASTENER PROBLEM



Keeping bucket in alignment despite frequent shocks and continuous vibration

The 2-cu. yd. bucket of this TRACTOLOADER*, built by Tractomotive Corporation, is retracted and dumped by hydraulic cylinders, which are connected to the bucket by a cross link and dump rod. The cross links pivot on the pins which connect them to the lift booms. All the movements of the bucket are transmitted through the cross link. Therefore, it is vital that all cross-link connections remain tight despite the necessary shock and vibration to which this hard working unit is subjected during its normal operation.

To protect these important bolted connections Tractomotive uses Elastic Stop® nuts. The red nylon collar® is an integral part of an Elastic Stop nut and is undersize in diameter in relation to standard bolt tolerances. This insert grips the entering bolt thread with strong, smooth nylon fingers that dampen impact loads and resist turning under the most severe conditions of vibration and shock. Nylon cannot gall bolt threads but this perfect thread fit serves to seal off internal nut and bolt threads against corrosion. This means easier removal for maintenance. And nylon's outstanding wear resistance assures extended reusability.

We suggest you check with ESNA for a practical, economical solution to your difficult fastening problems.

**Reg. Trademark of the Tractomotive Corp.*

MAIL COUPON FOR DESIGN INFORMATION

ESNA

Dept. S14-44, Elastic Stop Nut Corporation of America
2330 Vauxhall Road, Union, New Jersey

Please send me the following free fastening information:

☐ Bulletin on Elastic Stop Nut ☐ Here is a drawing of our product. What self-locking fastener would you suggest?

Name_____ Title_____

Firm_____

Street_____

City_____ Zone____ State_____

Circle 556 on Page 19

NOW, A STANDARD LINE OF DUFF-NORTON WORM GEAR JACKS

The economies of standardized production now can be realized by machinery designers who use Duff-Norton worm gear jacks for accurate positioning of loads weighing as much as several hundred tons. After 25 years of experience and hundreds of custom designs, Duff-Norton engineers have produced a standard line of eight jacks ranging from 2 to 100 tons in capacity which will meet almost any requirements. When jacks are used in an arrangement, added economy can be realized in raising unevenly distributed loads, since all models now have a uniform raise which permits jacks of varying capacities to operate in unison.

Worm gear jacks are purely mechanical devices, and they can hold heavy loads in position indefinitely without any creep. Functioning as components of machinery or equipment, they can raise or lower loads, apply pressure or resist impact. Worm gear jacks can be furnished with raises up to 24 inches, and they will provide exactly the same raise for years without adjustment.

Thousands of these jacks are in use on feeding tables, tube mills, welding positioners, pipe cut-off and threading machines, testing equipment, aircraft jigs, loading platforms, rolling mills, conveyor lines, and numerous other types of equipment. If you have a positioning problem, write for complete information, requesting Bulletin AD-66-V, which includes drawings and full specifications.

See Worm Gear Jacks At Booth 918, Design Engineering Show

DUFF-NORTON COMPANY

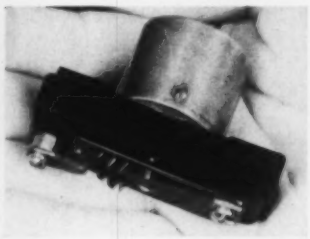
P. O. Box 1889 • Pittsburgh 30, Pennsylvania

COFFING HOIST DIVISION • Danville, Illinois

DUFF-NORTON JACKS
Ratchet, Screw,
Hydraulic, Worm Gear

DUFF-NORTON

COFFING HOISTS
Ratchet Lever
Spur Gear, Electric



and automatic safety-door lock for automobiles. Temperature range is −50 to 130 F, and resistance to vibration is 5 to 500 cps at 5 g. **Maxson Instruments Corp.**, 47-37 Austell Place, Long Island City 1, N. Y.

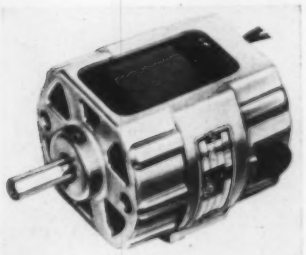
D

Circle 909 on Page 19

Small Motor

for intermittent-duty applications

Type FSE-23 motor is a series-wound, self-ventilated, 1/40-hp unit. Designed for use in intermittent-duty applications such as adding machines, calculators, and actuators, it has nominal speed of 5000 rpm and runs in a single direction, either clockwise or counterclockwise.



Height of 2 5/16 in. and rectangular shape permit motor to be mounted in a minimum of space. **Bodine Electric Co.**, 2254 W. Ohio St., Chicago 12, Ill.

J

Circle 910 on Page 19

High-Temperature Wires

use Teflon 100-X for insulation and jacketing

High-temperature wires, using Teflon 100-X as both primary insulation and jacketing material, exhibit physical, electrical, and chemical characteristics of conventional extruded Teflon-6 wires, but are available in long, continuous lengths. They meet requirements of MIL-W-16878, Type E. Also available is Turbo Tefsil, which uses a Teflon

Circle 557 on Page 19

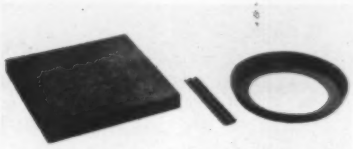
100-X jacket over thin-walled, silicone-rubber insulation. The combination of materials operates continuously at 250 C and has intermittent service life at 300 C. Insulation resistance is over 100,000 megohms per 1000 ft. Material has same general characteristics as Teflon wires, but is more flexible. It meets requirements of MIL-W-16878, Type EE. **William Brand & Co. Inc.**, Willimantic, Conn. B

Circle 911 on Page 19

Insulating Material

has low thermal conductivity

Min-K thermal insulating material is a bonded structure, reinforced with fibrous media, and containing



appreciable quantities of particulate matter. Pores in structure are so minute that a large proportion of gas molecules collide with walls of structure rather than with other molecules. Heat transferred by molecular conduction is therefore reduced below that which occurs in still air. Grades available include 500 series for low-temperature applications and 1300 series for high-temperature service. Min-K 1301, for extended use at temperatures to 1300 F, has excellent strength, resistance to vibration, and can be molded to special shapes (shown) with close dimensional tolerances. Material has many applications in the aircraft and guided-missile fields. **Johns-Manville Corp.**, 22 E. 40th St., New York 16, N. Y. D

Circle 912 on Page 19

Quick Couplings

for pressures to 10,000 psi

Series D quick couplings meet military specification MIL-C-4109A, and are interchangeable with other makes of couplings. Male, female, hose stem, and reusable hose-end connections are available in 1/4, 3/8, 1/2, and 3/4 in. sizes, with working pressures to 10,000 psi. Coupling

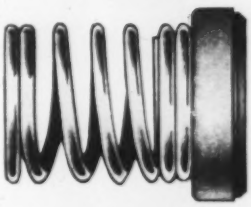
HOW TO SAVE MONEY

WITH SIMPLE, LOW COST

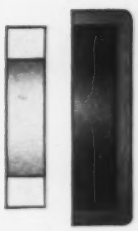
SEALOL flexibox

SEALS!

Actual size illustration of 5/8" Type R Sealol-Flexibox Seal



Optional stationary seal ring with its cup-type rubber gasket



Exploded view shows simplicity of seal design

Here's what makes this Sealol-Flexibox Seal so popular:

- Fewer Moving Parts than any other comparable seal . . . means greater reliability!
- Competitively Priced . . . the low cost will amaze you!
- Long Lasting . . . no close-tolerance, precision-fitted rubber parts to wear out!
- Special Conditions met through use of new O-Ring materials!
- Unique Spring Drive . . . the packing's only function is to seal. Rugged, straight or conical drive spring assures flexibility required for optimum sealing surface at all times.
- Sliding O-Ring . . . allows for end play and axial runout!
- Immediate Delivery . . . all popular sizes are stock items. Order today!

SEALOL

SEALOL CORP, 344 Post Road, Providence 5, R. I.

Please send me Bulletin describing unique Spring Drive Seals . . .

Name ..... *Title* .....

Company .....

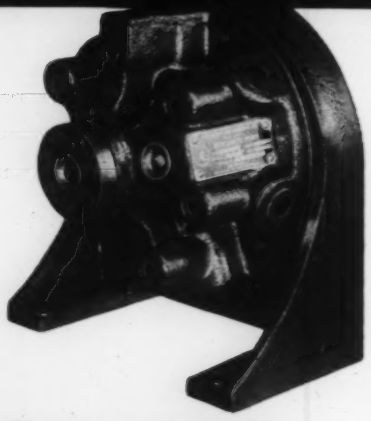
Street .....

City ..... *State* .....

Circle 558 on Page 19

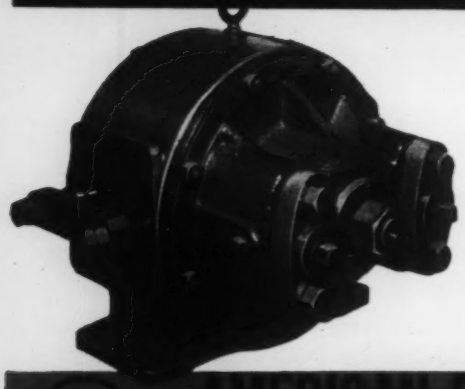
For highest quality
when the pressure's on . . . it's
HELE-SHAW and HYDRAMITE
HYDRAULIC PUMPS

for constant displacement . . .
HYDRAMITE



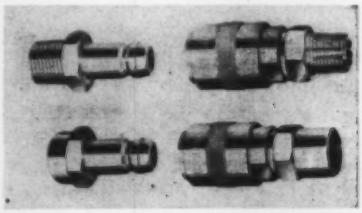
- Pressures to 5,000 psi
- Capacities of 3, 5, 10 gpm and up
- No supercharging needed
- Efficiencies over 85%
- Either rotation for direct drive

for variable displacement . . .
HELE-SHAW



- Instantly reversible
- From 0 to 3,000 psi
- Capacities from 3 to 110 gpm
- Infinitely variable discharge
- Many types of controls

AMERICAN ENGINEERING COMPANY
Dept. P-147, Wheatsheaf Lane & Sepviva St., Philadelphia 37, Pa.
CANADIAN SUBSIDIARIES: Affiliated Engineering Corporations, Ltd.
Montreal, P. Q. . . . Brandon Industries Ltd., Toronto, Ont.



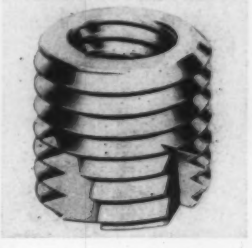
locks automatically, without turning or twisting. Locking mechanism makes a positive, leakproof connection, resistant to impact or rough handling. Full 360-deg swivel action is provided. Applications include pneumatic tools and equipment, and missiles and rockets. **Perfecting Service Co.**, 332 Atando Ave., Charlotte 6, N. C. A

Circle 913 on Page 19

Self-Tapping Insert

for installation in softer-than-steel materials

Speed-Sert incorporates four sharp cutting edges to cut its own thread as it is rotated into a cored or drilled hole. Design of the cutting edges provides adequate chip flow and prevents chips from entering into internal thread. Simple installation tool fits into a standard tapping head. Insert is designed for installation into aluminum and magnesium alloys and plastics to provide a steel



thread in softer-than-steel materials. Used as original equipment, insert protects against stripped threads. It is available in cadmium-plated carbon steel, stainless steel, and brass. **Newton Insert Co.**, 6500 Avalon Blvd., Los Angeles 3, Calif. L

Circle 914 on Page 19

Mercury Switch

nylon-enclosed unit resists shock and splashing fluids

Nylon-enclosed mercury switch, designated 7 MP1-2, consists of a glass-tube mercury switch embedded

Designers who look to Nylon look to NATIONAL first

For fabricated parts—or for extruded strip, rod, tubing or special shapes—you'll find National a dependable primary source of Nylon. Costly molds and time delays may favor the delivery of 100% usable parts fabricated from National Nylon and timed to your production needs.

In many cases, fabricated parts from standard or special extruded shapes give you more design freedom at no greater unit cost. Buying from the source makes this possible. Before you "freeze" a molded design, talk with your National Sales Representative.

Check him, also, for your other basic materials needs—PHENOLITE® Laminated Plastic, Vulcanized Fibre, PHENOLITE Copper-clad. Many grades from the more than 100 available—including Nylon rod—are "in stock" for immediate shipment. For Nylon sizes, grades and properties, write Dept. G-4 for our Technical Data Folder.

NATIONAL VULCANIZED FIBRE CO. WILMINGTON 99 DELAWARE

In Canada: NATIONAL FIBRE CO. OF CANADA, LTD., Toronto 3, Ont.

Circle 560 on Page 19

GEAR-GRIP

The most revolutionary Flexible Coupling Design Development in a century!

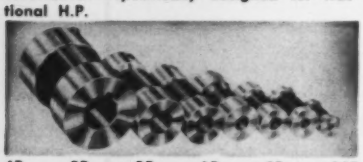
Now available for sub-fractional, fractional and integral H.P.

Ability of rubber Flex-Element to float between captive end fittings distributing load similar to universal joint action.

- Load Ranges—1/12 H.P. through 30 H.P.
- Shaft Sizes—1/8 through 1-7/8.
- Specified exact length to design requirements per series.
- Prevention of end thrust among many other design advancements.

Dyna-Line . . .

The finest flexible coupling in single unit construction—specifically designed for fractional H.P.



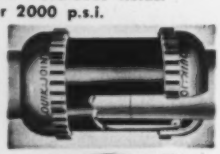
4R 3R 2R 1R 0R 00R

- True Flexibility and Torsional Resilience for quiet, load-plus power transmission without extreme deflection or twist.
- Lengths varied to design specifications in each series.
- Load ranges—1/15 to 1½ H.P.
- Shaft sizes—3/16" to ¾".

Quick-Joint

Steel Compression Pipe Fittings

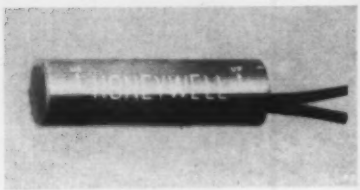
- UL approved for hazardous fluids.
- Guaranteed for 2000 p.s.i.
- Allows 7° angular deflection.
- No threading of pipe required.
- Special S111-cone Gasket for Steam applications.



Write for Catalogs and Technical Bulletins.

Guardian PRODUCTS CORP.
COUPLING DIVISION
Dept. M-48
Michigan City, Indiana

in synthetic rubber and enclosed in a nylon can. Resilient embedment material lessens effect of vibration and provides insulation and seal for lead entrance. Unit resists shock, oil, alkalis, and acids, and is unaffected by water or vapor, making it suitable for photographic and testing applications where chemical splash is a factor. Small operating



force and ability to repeat operation at same angle of tilt assure precision performance. Temperature range is −35 to 200 F. Contact arrangement is single-pole, single-throw. Switch is rated at 3 amp, 115 v dc, resistive load. **Micro Switch, Div., Minneapolis-Honeywell Regulator Co.,** Freeport, Ill. K

Circle 915 on Page 19

Bushing

for engine mounting

Pyrotex engine-mounting bushing, designated U. S. 9526-D1, is for trucks and farm equipment. Dimensions are 2.972/2.976 in. OD, 2.007/2.012 in. ID, and 1.78/1.84

in. long. Applications usually specify two bushings per unit. **Equipment Sales Div., Raybestos-Manhattan Inc.,** Bridgeport 2, Conn. B

Circle 916 on Page 19

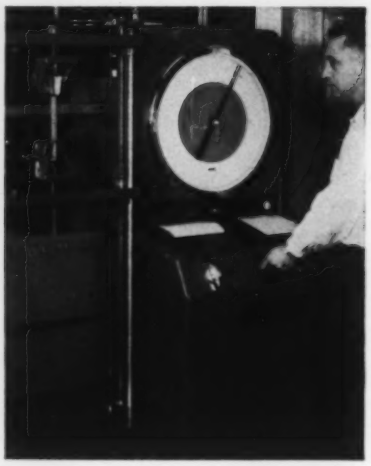
Small Reset Counter

has speed of 1000 strokes per min

New small reset counter has capacity of 9999 or 99999; figures return to zero after maximum count has been reached. Unit has speed of

Somers THIN STRIP

PHYSICALLY FIT



Exacting physical requirements such as fatigue resistance, tensile strength and drawing properties are easily met by SOMERS, where complete facilities include a modern laboratory equipped for chemical, electrical and performance testing of all SOMERS THINSTRIP—both in process and before shipping.

The latest electronic gages, controls and other precision instruments guarantee uniform quality every time in nickel and its alloys from .020" and copper and its alloys from .010", both down to .000175".

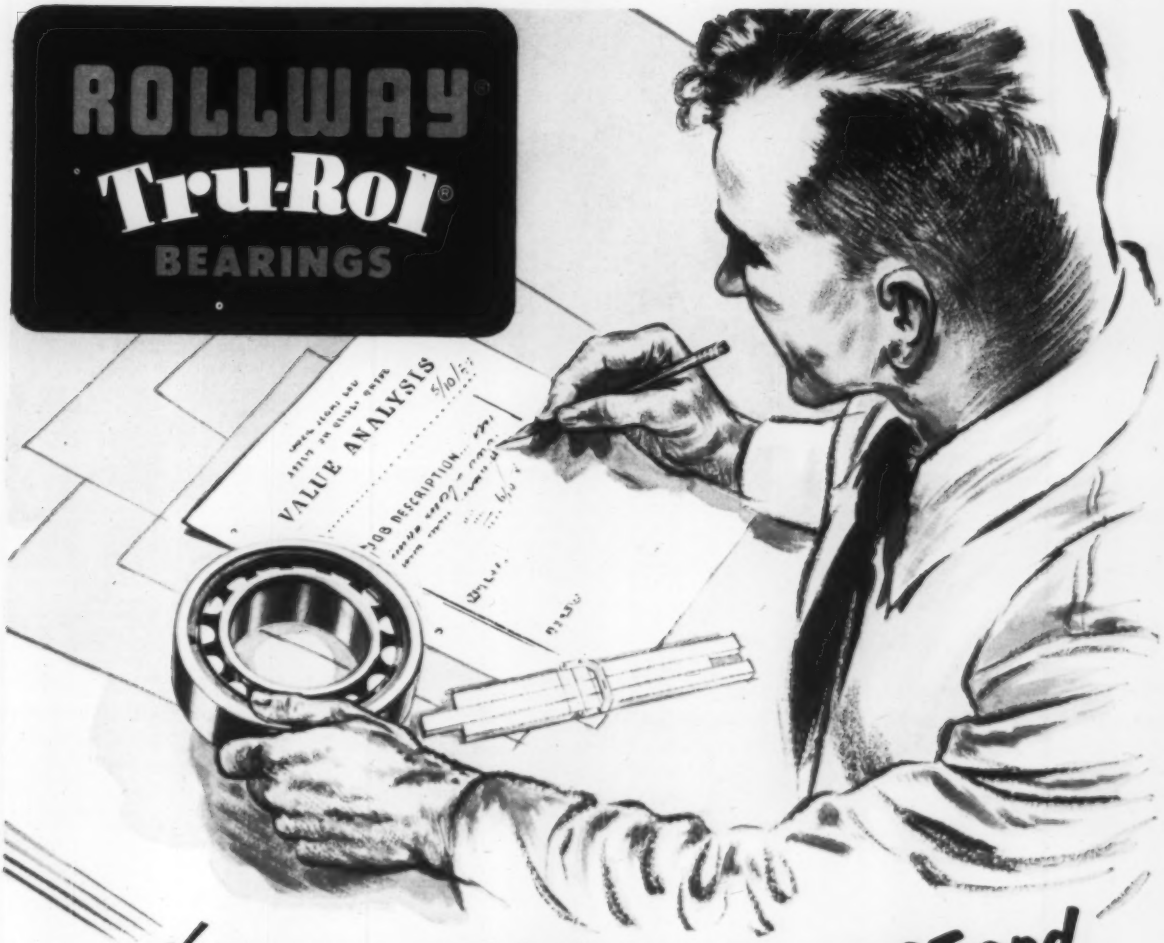
Special requirements are "run of the mill" for SOMERS. Write for confidential data blank or field engineer.

FOR EXACTING STANDARDS ONLY
Somers

Somers Brass Company, Inc.
120 BALDWIN AVE., WATERBURY, CONN.

Circle 561 on Page 19

Circle 562 on Page 19



For a sound balance of LOW COST and HIGH PERFORMANCE

When you need maximum precision bearings, buy them. They'll save you money. Rollway has them in all types and sizes.

But in hundreds of applications, maximum precision means *unused* precision. The speed, load and life-expectancy demands are not critical. For these spots, Rollway's Tru-Rol Bearings are engineered to give all that is required in performance at worthwhile savings in cost.

Maximum-Type Design and Construction Principles

The Tru-Rol segmented steel retainer is the strongest, most durable available in commercial-grade bearings. Its separator segments are formed to the curvature of the roller for true axial alignment. In combination with rollers crowned to provide equal load distribution, it withstands heavy shock and reversing loads over long periods.

For all the precision and performance you need and can use in non-critical applications, ask a nearby Rollway Service Engineer to brief you on Rollway Tru-Rol characteristics and versatility.

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SYRACUSE, NEW YORK

ENGINEERING OFFICES: Syracuse • Boston • Chicago
Detroit • Toronto • Pittsburgh • Cleveland
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Los Angeles • San Francisco

Circle 563 on Page 29

WHICH MONARCH FINISH WILL STIMULATE YOUR SALES?

Gleaming Polish highlights many of today's "best-selling" products produced from Monarch aluminum permanent mold and diecastings.

Colorful Porcelain Enamel offers a modern decor to create "buy appeal". "Porceglaze" economically adds a new feature to products made from Monarch permanent mold castings.

Durable Velvaglaze provides a pleasing, economical scar and mar resistant finish on both Monarch aluminum permanent mold and diecastings.

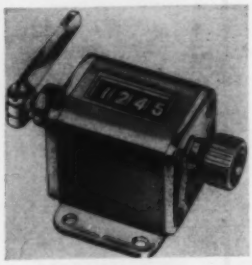
Monarch is famous for finishing quality castings. It will pay you to get full details. Write for our brochure "Manufacturing Achievements in Molten Aluminum".

MANUFACTURING in MOLTEN ACHIEVEMENTS ALUMINUM

MONARCH ALUMINUM MFG. COMPANY

9205 Detroit Avenue Cleveland 2, Ohio

Circle 564 on Page 19



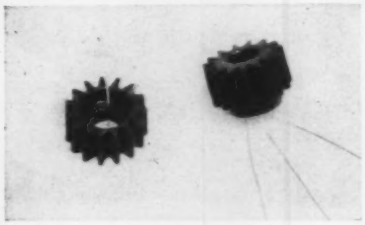
1000 strokes per min. Figures are normally read from a plane parallel to the base, but mounting flanges can be moved 90 deg in either direction to improve reading position. Nylon driveshaft input bearing requires no lubrication. All shafts are stainless steel to resist corrosion. Left or right-hand drive is available, with reset knob at opposite end. Revolution counter registers in one direction, regardless of direction of driveshaft input. It can be obtained to add or subtract, but not both. **Technicraft**, 6222 Ridge Ave., Philadelphia 28, Pa. E

Circle 917 on Page 19

Transistor Radiator

fits over JETEC-30 package

Transistor radiator, designated 3AL-635, press fits over JETEC-30 transistor case without interfering with operation or servicing. Material of the finned jacket is black-anodized



aluminum alloy. Radiator maintains dissipation coefficient of 0.28 C per mw. **Industrial Div., Birtcher Corp.**, 4371 Valley Blvd., Los Angeles 32, Calif. L

Circle 918 on Page 19

Centrifugal Pumps

are elastomer-lined units

Eight sizes of low-head centrifugal pumps have linings of natural rubber, neoprene, and hypalon. They protect process fluid from off-taste and off-color effects, will not introduce impurities, and resist damage

NEW! LOW-COST SINGLE COIL INDUCTION MOTOR

New in design, new in economy — the Heinze P Motor answers your need for a low-cost single coil 2 pole induction motor. It is available in various stacks and horsepower ratings from 1/300 to 1/50. Free speed is 3400 rpm; load speed 3000 rpm. Designed for 115 V, 60 cycle operation, the Heinze P Motor has broad application — in movie projectors, fans, gearmotors, advertising displays, pumps, toys, etc.

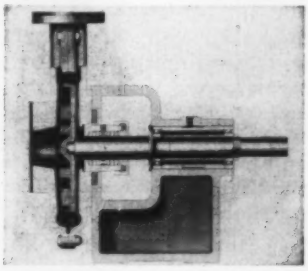
You have a wide choice of models from the comprehensive line of Heinze sub-fractional horsepower motors and blowers. Heinze Engineers are also ready to adapt standard models — or design a complete new motor or blower for your exact needs. Send us your product and specifications. We'll adapt a motor . . . at no obligation. Write for catalog.

HEINZE **ELECTRIC COMPANY**

685 Lawrence St., Lowell, Mass.

Circle 565 on Page 19

by stray currents in plating baths and from galvanic effects. Mechanical seals and packed stuffing boxes are interchangeable. Eight capacities range from 1 x 1 in., rated 30



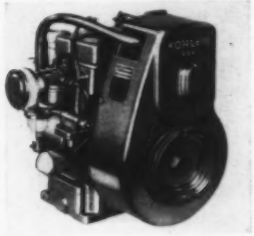
gpm at 20 ft TDH, to 2 x 2 in., rated 200 gpm at 85 ft TDH. **Ampco Metal Inc.**, 1745 S. 38th St., Milwaukee 46, Wis. K

Circle 919 on Page 19

Water-Cooled Engine

develops 6.5 hp

L160 compact, lightweight water-cooled engine, for applications where cooling air is limited and quiet operation is desired, develops 6.5 hp. Designed primarily for inboard marine applications, it can be installed wherever bulk water or city water is available. Positive displacement sea-water pump with neoprene impeller, driven by a belt located under flywheel housing, provides



ample cooling. Temperatures are thermostatically controlled with excess water routed through a bypass. Air cleaner is a dry, aluminum-mesh type which serves as a backfire trap. **Kohler Co.**, Kohler, Wis. K

Circle 920 on Page 19

Cast Acrylic Sheet

provides uniform shrinkage when heated and formed

Unshrunk cast acrylic sheet, designated Plexiglas G, is supplied untrimmed in sizes 2.5 per cent longer

New... Valcor

ALL-WELDED V-28100 Series Features Reliability

...the only all-metal, in-line solenoid valve with an optically-flat seat!

The all-new Valcor V-28100 Solenoid Valve eliminates all internal or external non-metal seals. All-welded, all-metal, the V-28100 is designed to minimize temperature and media problems for the long life of the valve. The V-28100 features an optically-flat, hard-faced seating, one of the many unusual engineering designs responsible for Valcor's wide acceptance throughout industry. And because of its all-metal construction, the shelf life of the V-28100 is unlimited.

Featuring compact size and low weight, it is especially valuable in missile and aircraft design.

Write for complete technical data and literature today.

The new V-28100 series cover the following range—

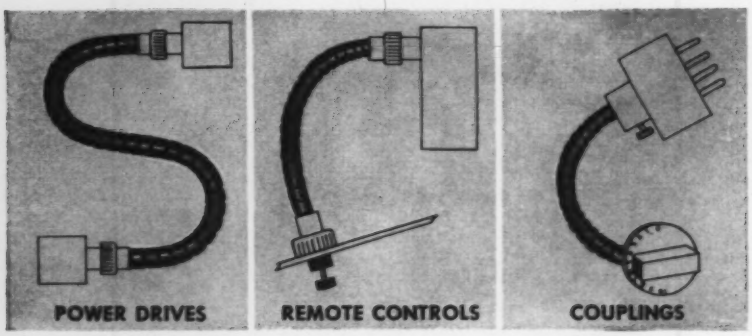
MEDIA: Fuels, hydraulics, pneumatics, liquid gases
TEMPERATURE RANGE: -300°F to +600°F
DIMENSIONS: 1.25" x 2.60"
RESPONSE: 15 milliseconds
VOLTAGE: 18-30 volts DC
PRESSURE RANGE: 0 to 3,000 psi
FLOW EQUIVALENT: .020 to .125 sharp edge orifice

VALCOR SOLENOID VALVES

VALCOR ENGINEERING CORP.
5365 CARNEGIE AVENUE, KENILWORTH, NEW JERSEY
SEE YOU AT THE DESIGN SHOW . . . Booth 567

Circle 566 on Page 19

FLEXIBLE SHAFTS MEET PRODUCT DESIGN NEEDS THAT NO OTHER COMBINATION OF ELEMENTS CAN MEET SO SIMPLY AND ECONOMICALLY!



Lick the problems of designing smaller units . . . simplifying assembly . . . cutting production costs . . . with Robertshaw Flexible Shafting. Eliminates all the restrictions imposed by rigid shafting and connections in transmitting power or control between two points. No alignment problems. Connected members can be positioned for greatest efficiency and space-savings. Weight can be reduced substantially in many units.

Every inch of Robertshaw Flexible Shafting is "custom-made" to your exact needs for aircraft, automotive, appliance, machinery, radio, TV, electronic, portable tool and special applications. Complete engineering help on new or known uses.

Write for Engineering and Design data

Mr. Controls® Robertshaw-Fulton CONTROLS COMPANY

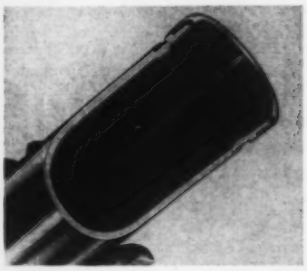
FLEXIBLE SHAFT DIVISION • 110 Summit Ave., Chatham, N. J.

and wider than corresponding preshrunk sizes, to allow for shrinkage when heated and formed. Material provides maximum flatness for applications that do not involve forming, such as glazing. It also provides uniform shrinkage for uses where sheets are silk-screened or cut to size in the flat before forming. Thicknesses of 0.060 to 0.250 in. are available in colorless transparent and in colors. Material is also offered with patterned and matte-finish surfaces, and in extra-large sizes from 72 x 120 to 102 x 120 in. **Plastics Dept., Rohm & Haas Co.,** Washington Square, Philadelphia 5, Pa. E

Circle 921 on Page 19

Pipe

of steel and plastic carries corrosive materials



Jal-Jacket pipe consists of a rigid, polyvinyl-chloride tube jacketed with an electrical resistance welded-steel pipe. It has applications where corrosion is a problem, and attains working pressures of 1000 psi at 150 F. Pipe is available in 20-ft lengths in 2, 3, and 4-in. nominal OD sizes. **Public Relations & Advertising Dept., Jones & Laughlin Steel Corp.,** 3 Gateway Center, Pittsburgh 30, Pa. F

Circle 922 on Page 19

Low-Voltage Capacitors

for outdoor industrial applications

Type LSO small low-voltage capacitor equipment for outdoor industrial applications is available in ratings from 60 to 180 kvar, 230 v, and 80 to 240 kvar, 460 and 575 v, 60 cycles. Equipment consists of individually fused capacitors assembled in a weatherproof housing. The 230 v equipment uses 15-kvar units, and 460

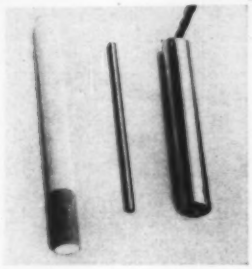
and 575-v equipment contains 20-kvar capacitors. Removable plate at base of equipment provides for incoming-line connections. Capacitor units are of welded-steel-case construction and have built-in discharge resistors. Cases are grounded to housing through mounting bolts. Grounded terminal is provided on outside of housing for connecting to system ground. **General Electric Co.**, 1 River Rd., Schenectady 5, N. Y. C

Circle 923 on Page 19

Differential Transformer

has diameter of only 3/8 in.

Differential transformer is 2½ in. long and 3/8 in. in diameter. Ceramic bobbin is wound with Teflon-insulated wire and is encased in a



stainless-steel shell. Coil is vacuum impregnated with silicone varnish. Sensitivity is 0.25 mv output per 0.001 in. displacement per v input at 60 cps. Input is 1.5 v, 60 cycles; output is 77 mv at 0.200 in. armature displacement and 93 mv at 0.250 in. displacement. **Automatic Timing & Controls Inc.**, King of Prussia, Pa. E

Circle 924 on Page 19

Check Valve

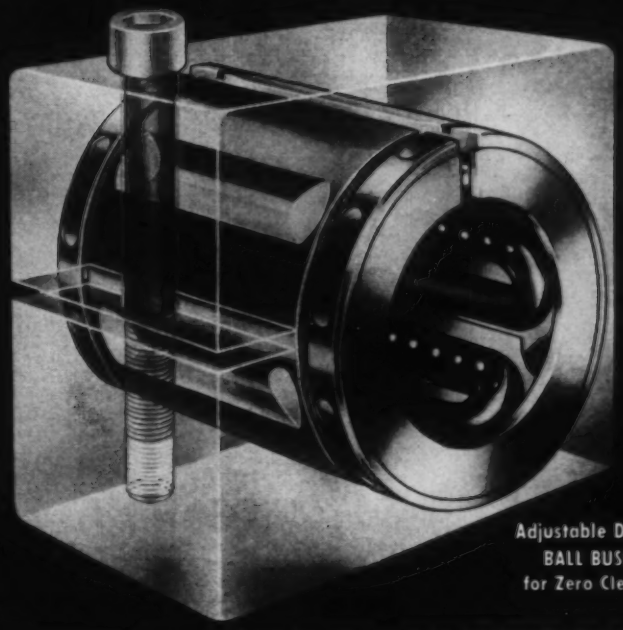
is pilot-operated unit for air service

Main application of PM-294 pilot-operated check valve is in a circuit

Circle 568 on Page 19→

NOW! *Adjustable Diameter and Open THOMSON*

BALL BUSHINGS



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The BALL Bearing for *all* your **LINEAR MOTIONS**

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Open BALL BUSHING for Zero Clearance on Supported Shafts

Sliding linear motions are nearly always troublesome. Thousands of progressive engineers and designers have solved this problem by application of BALL BUSHINGS on *guide rods, reciprocating shafts, push-pull actions,* or for support of *any mechanism that is moved or shifted in a straight line.*

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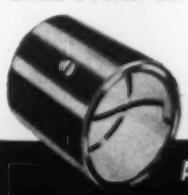
LONG LIFE • LASTING ALIGNMENT

The various types cover a shaft diameter range of ¼" to 4". Small sizes available in Stainless Steel. Write for literature and name of our representative in your city.



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SPLINED SHAFTS — Lengths to 72".

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Note: All of the sizes above are approximate.

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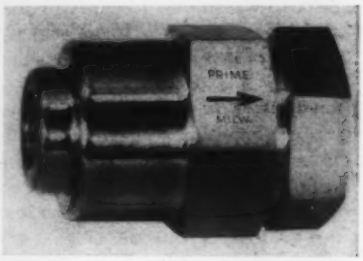
where two or more three-way directional valves control one cylinder. It permits each directional valve to extend and retract the cylinder independently without loss of air from exhaust port of other directional valves. Unit allows free flow in direction of arrow (also in reverse direction) as long as 3-psi minimum back pressure is available. With no back pressure, valve acts as an



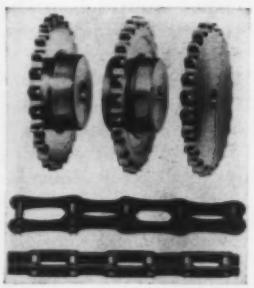
ordinary check valve. Of brass and stainless-steel construction, it is 2¾ in. long. **Prime Mfg. Co.**, 1669 S. First St., Milwaukee 4, Wis. K

Circle 925 on Page 19

Sprockets and Chains

in new sizes for light and heavy duty

New sizes of standard sprockets and chains have been added to a line of heavy and light-duty units. Steel and iron sprockets for 1½, 1¾, and 2-in. pitch chain have been added to heavy-duty range. These include plate, single-hub, and double-hub types. Available in the light-duty range are steel-plate sprockets and sprockets with hub for ½ to 1¼-in. pitch chain. Other additions include double-pitch roller chain in three commonly used types.



New types and sizes extend line to cover all drive needs from ¼ to 2-in. pitch. **Boston Gear Works**, 14 Hayward St., Quincy 71, Mass. B

Circle 926 on Page 19

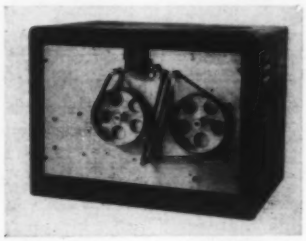
ENGINEERING
DEPARTMENT

EQUIPMENT

Random Access Memory

miniature unit stores up to 10 million bits

Model 3270 miniature random access memory, designated Miniram, stores up to 10 million bits with average access time of less than ½ sec. Unit consists of a tape-transport mechanism with completely transistorized drive and programming circuitry. Each of two reels on the transport contains approximately 35 ft of 1-in. tape which can be swept past the head in either direction in less than ½ sec. Direction of tape travel is determined by input programming. At end-of-tape a preprogrammed



50-millisec stop is inserted, after which tape travel is reversed. Unit can be programmed to return to center of tape after each look-up or can be stopped at end-of-tape or at any point desired. Individual transport units can be ganged to form a bank capable of storing virtually any amount of digital data. **Potter Instrument Co. Inc.**, Sunnyside Blvd., Plainview, L. I., N. Y. D

Circle 927 on Page 19

Power Supply

portable unit measures 6 x 8 x 8 in.

PS38A-1 miniature regulated power supply is designed for laboratory work or for field use as a quick source of dc power on operational aircraft electrical equipment. The small, portable unit maintains precise voltage control during large

IT PAYS TO HAVE HUBBELL GOOD CONNECTIONS

secure your product quality with HUBBELL premium miniatures

Here are the "tremendous trifles" upon which product quality depends. Hubbell miniature screws assure efficiency in your assembly operations, dependable product operation and long term product life and user satisfaction.

Hubbell miniatures are the finest obtainable. They are available in sizes #0 and #1 in steel, stainless steel or brass; and in head styles and sizes to meet your most exacting needs.

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Pressure-sensitive labels provide convenient identification by size and type; reseal the box securely after opening.

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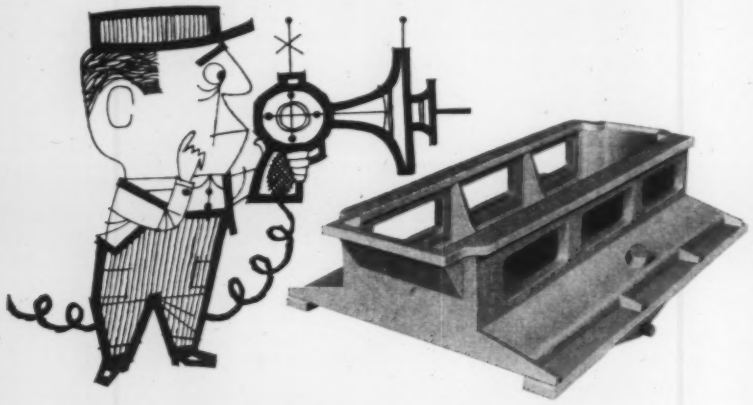
Circle 571 on Page 19



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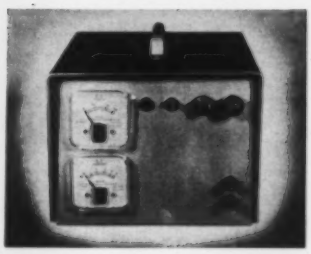
Littleford Bros. Inc. 512 E. Pearl Street Cincinnati 2, Ohio

Circle 572 on Page 19



transient or steady-state load current and line-voltage variations. It supplies up to 4 amp at 28 v dc output and operates from input power source of 105 to 125 v ac and 380 to 420 cps. Unit can be mounted in any position, measures approximately 6 x 8 x 8 in., and is equipped with a carrying handle. **Magnetic Controls Co.**, 6405 Cambridge Ave., Minneapolis 26, Minn. J

Circle 928 on Page 19

Strain-Gage Load Cells

electrically measure forces and weights

Series of precision strain-gage load cells, in small, hermetically sealed housings, are designed in nine capacities to cover range from 500 to 200,000 lb. Cells, designed for electrical measurement of forces and weights, incorporate construction which provides up to 250 per cent greater output with consequent reduction of interference from stray signals. Rugged cell construction permits 225 per cent overload without affecting calibration. Special

cell cable has zero moisture absorption and stainless-steel jacket. **Cox & Stevens Electronic Scales Div., Revere Corp. of America**, Wallingford, Conn. B

Circle 929 on Page 19

Pressure Pickup

has unbonded strain-gage sensing element

Type 4-322 differential pressure pickup operates within specifications on line pressures as high as 350 psi,

while measuring pressures in ranges of ±7.5, 12.5, 25, and 50 psid. Unbonded strain-gage sensing element is encased in a stainless-steel cube. Symmetrical construction with close proximity of sensing-element windings insures good thermal response. Packaged with a built-in, miniature,

hermetically sealed connector, pick-up requires no soldering or potting of electrical leads for connection. Unit is designed for rugged use, such as in bench, test-stand, and wind-tunnel applications. **Consolidated Electrodynamics Corp.**, 300 N. Sierra Madre Villa, Pasadena, Calif. L

Circle 930 on Page 19

Spray Fixative

permits erasure and reinking

Fixatene spray fixative allows lines to be added over treated areas and permits easy erasure, repencilling or reinking. Spray protects pencil and ink lines against smudging on drawing films, natural or transparentized tracing papers, tracing cloth, and is effective also as a fixative in illustration work involving charcoal or pastels. Spray is available in 12-oz aerosol containers. **Keuffel & Esser Co.**, 260 Madison Ave., New York 16, N. Y. C

Circle 931 on Page 19

Power Supplies

low-voltage dc units are transistorized

Six low-voltage, high-current dc power supplies, called Q Nobatrons, have tubeless circuitry, low ripple, fast response, transient-free performance, adjustable output, wide input frequency range, and isolated output. Excellent ripple and response characteristics make them suitable for applications where smooth output and rapid recovery

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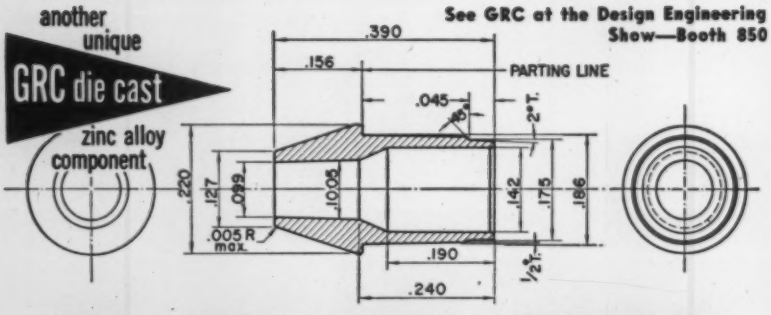
Circle 573 on Page 19



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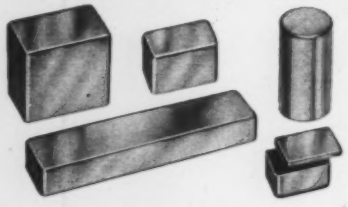
Circle 574 on Page 19



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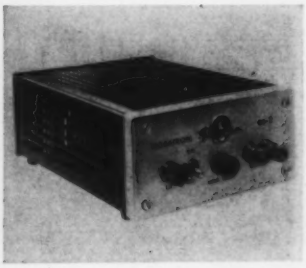
Circle 575 on Page 19



are required, such as in computer circuits and strain gage bridges. Input voltage is 105-125 v ac, single phase. Output-voltage ranges are 4.5-8, 9-18, and 18-36 v. Output voltage regulation is ± 0.25 per cent for line and load changes combined. Ripple is 0.01 per cent for all but one unit, which has ripple of 0.02 per cent. Ambient temperature range is zero to 40 C. **Sorensen & Co. Inc.**, Richards Ave., South Norwalk, Conn. B

Circle 932 on Page 19

High-Temperature Cements

for strain-gage application

Brimor high-temperature cements are used to secure wire and foil strain gages to components prior to high-temperature tests. Cements are particularly suited to heat-resistant steels and nimonic alloys, and when applied to these materials they have operating range to 750 C. They can also be applied to low-alloy steels, cast iron, and some nonferrous materials such as brass, titanium, copper, and aluminum alloys. Brimor U527 is a medium-hardness cement used where strains in test component are large and are associated with high-frequency vibration. Brimor U529 has a higher bond strength, producing a hard, tenacious cement when cured. It is used when a high degree of adhesion is required. **Morganite Inc.**, 3302 48th Ave., Long Island City 1, N. Y. C

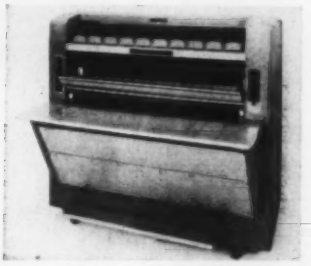
Circle 933 on Page 19

Whiteprint Machine

prints and develops at speeds to 100 fpm

Printmaster 1000 is a high-speed, high-volume whiteprint machine for the reproduction of drawings and other forms. Machine accommodates materials up to 54 in. wide, in any length, and prints and de-

velops at speeds to 100 fpm. High print quality is assured by a 9000-w hermetically sealed high-pressure mercury-vapor lamp with continuously variable intensity from 60 per cent to full. Uniform cooling of



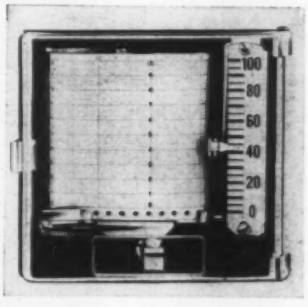
lamp and cylinder produces a sharp print and permits processing of foils and film positives without sticking. Unit is wired for 220 v ac, 60 cycle, single phase. **Ozalid Div., General Aniline & Film Corp.**, 13 Corliss Lane, Johnson City, N. Y. D

Circle 934 on Page 19

Pressure Gage

records on 3-in. strip chart

Recording pressure gage, available in ranges from 0-3 to 0-60 psi, uses a 3-in. strip chart. Elements in various ranges are offered in Ni-Span C, beryllium copper and phosphor bronze. Recording chassis is interchangeable and can be plugged in,



without use of tools, from front of panel. Models are available with pneumatic or electric-chart drives, in a variety of chart speeds. **Bristol Co.**, Waterbury 20, Conn. B

Circle 935 on Page 19

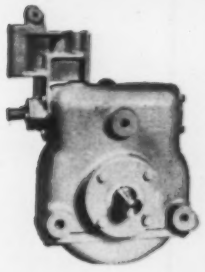
Digital Voltmeter

measures dc and ac voltage and resistance

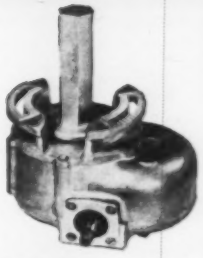
All-electronic digital voltmeter, designated Model 5350, measures both dc and ac voltages and resistances to

Special OHIO SPEED REDUCERS

Heavy duty, hand-operated reducer with overload clutch used in automotive engine machining plants.



Right angle worm gear drive for industrial stoker applications.



Combination planetary and worm gear reducer for resetting circuit breakers in electrical power stations.

Combination clutch and speed reducer for powering mechanical bowling pinsetter. Input shaft turns constantly.

"Engineered" To Your Specifications

• If the design of your machine calls for a *special* speed reducer . . . OHIO is the place to get it! An experienced staff of power transmission engineers can help you modify a standard reducer to solve your problems or, design and build an entirely new speed reducer to meet the demands of your application.

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Manufacturers of gears and speed reducers - both stock and special

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Circle 576 on Page 19

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WEARING PART
FORMULAS

developed specifically for
your requirements

PROMET ENGINEERED BRONZE

does not powder in severest service nor cut or stick to the shaft because of temporary lubrication failure.
Write for literature and service data sheets, or send prints and condition of operation for recommendations and quotations.

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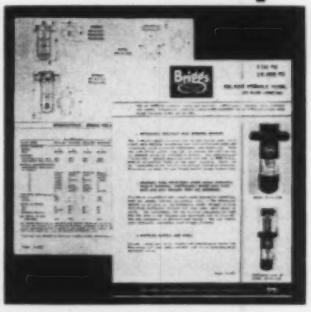
Circle 577 on Page 19

IF YOU ARE DESIGNING
NEW HYDRAULIC EQUIPMENT
WORKING FROM 0 TO 5000 PSI
. . . BY ALL MEANS WRITE
FOR BRIGGS' NEW BULLETIN
COVERING THIS SUBJECT



This new bulletin fully describes a rugged IN-LINE, constant, high working pressure hydraulic filter than can take SHOCK AFTER SHOCK . . . day in and day out. Made especially for conditions demanding a hydraulic fluid filter "that can take it."

See how well it will fit in with your plans to prevent sticking valves and erratic machine performance. It shows how to get FULL, EASY, SMOOTH production. Packed with practical information, specifications and drawings. Use the coupon, no cost, no obligation.

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HYDRAULIC OIL AND FLUID FILTERS

with interchangeable cartridges for mineral oils or non-inflammable fluids . . for by-pass, in-line, or high flow installations.

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SEND BULLETIN without obligation describing your heavy duty, in-line, high pressure hydraulic fluid filter.

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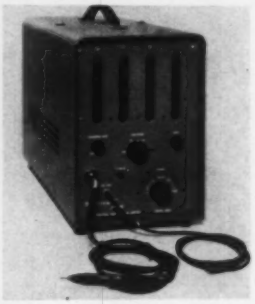
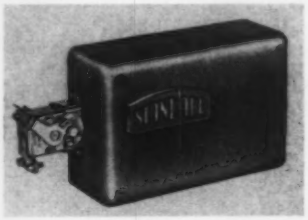
accuracies of 0.5 per cent. It is equipped with an automatic polarity indicator, decimal-position indicator lights, accurate oven-controlled reference voltage for calibration and ac/dc switch-type probe. Readings to 150 per cent of full scale are properly indicated, even if input goes beyond range setting. Selectable ranges are: dc volts ±1/10/100/1000; ac volts ±1/10/100/1000 rms; resistance 10k/100k/1M/10M. Sampling rate is variable or can be externally controlled. **Berkeley Div., Beckman Instruments Inc.**, 2200 Wright Ave., Richmond 3, Calif. M



Circle 936 on Page 19

Converter

changes 28 v dc to 400-cycle ac



New dc converter, designated Model D-400, is a transistorized power pack that provides 400-cycle source for operational, test, or developmental applications. It converts 24 to 30 v dc to 400 cycles with output of 10 w. Accuracy is rated at ±0.07 per cent, and remains constant with input voltage variations to ±10 per cent. Completely enclosed, unit contains only one moving part, a miniature tuning fork. Applications include use in guidance systems, power generators, nuclear counting, ballistic measurement, radar, and high-speed photography. **Standard Electric Time Co.**, 89 Logan St., Springfield, Mass. B

Circle 937 on Page 19

Professional Viewpoints

. . . the lone wolf— pro and con . . .

To the Editor:

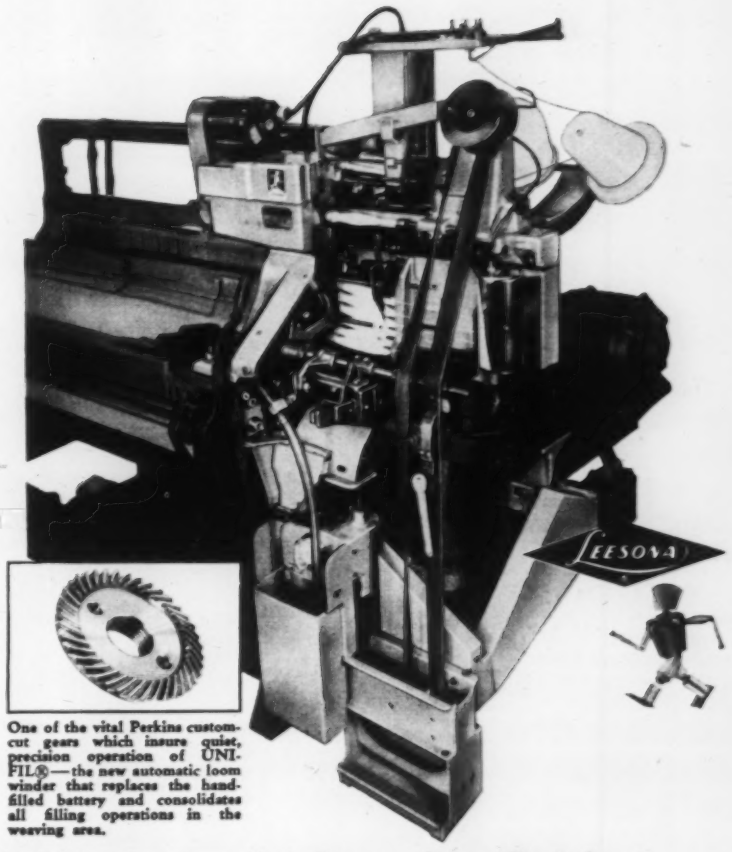
In reference to your editorial, "The Lone Wolf," in the February 20 issue, I must say I do not agree that registering or belonging to a society indicates that a man has more professional leanings than one who does not belong. In the United States, we have a tendency to be joiners just to get our names on a membership list. Engineers, however, weigh values carefully and unless they are convinced they are obtaining their money's worth, they will not invest.

Your point—that since memberships run only 25 per cent of the eligible engineers, the nonjoiners have only themselves to blame if the society appears to be dominated by a nonrepresentative group—does not get at the real issue. To me, the real issue is the problem of the many different facets of engineering in existence today.

Consider the variety of fields of specialization available to the engineer. First, the main categories of electrical, mechanical, chemical, civil, etc., provide a basic differentiation. Selecting one main branch —the mechanical field—we can further subdivide into such categories as heavy industry, such as large earth-moving equipment; medium sized industry, such as automotive and aircraft; and the smaller industries, such as electromechanical components.

Diversity of Problems

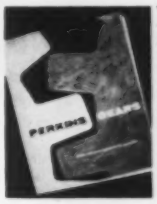
In each of these three groups, which have entirely different problems, we further specialize to the point where we have research, design, development, test, process, materials, and other engineers—plus administrative and management engineering groups. This indicates that there must be several hundred types of engineers, each with specific problem areas. I will haz-



One of the vital Perkins custom-cut gears which insure quiet, precision operation of UNIFIL®—the new automatic loom winder that replaces the hand-filled battery and consolidates all filling operations in the weaving area.

Perkins Custom-Cut Gears Specified for Universal Winding's New Unifil® Loom Winder

Quality and service determine Universal Winding Company's choice of Perkins custom-cut gears for many of their machines, including the new UNIFIL®. Perkins gears are precisely cut to exact specifications which eliminate noise, wear and backlash. This means fewer rejects, lower maintenance cost and longer gear life. Extensive facilities and modern equipment, backed by 52 years of gear-making know-how insure prompt delivery, as scheduled, to meet production needs. You, too, can benefit from Perkins *quality* and *service*. Perkins can cut your gears from any material — metallic or non-metallic. If you require a special deep or shallow pitch, a gear with a hub, clutch teeth or other special features, Perkins engineers will work with you to insure efficient and economical gear design. Ask us to quote on your next gear requirement.



YOURS ON REQUEST — Folder illustrating gears Perkins has made — face gears, generated and curvic clutches; bevel, spiral, helical and spur gears; ratchets, sprockets and ground thread worms . . . from all materials. Includes Perkins facilities for producing various gear types and sizes. *Write today.*

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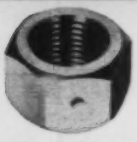
Circle 579 on Page 19

MACLEAN-FOGG

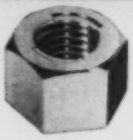
gives you product superiority and fast, low-cost assembly with the M·F line of lock nuts and standard nuts in all sizes "off the shelf"

M·F TWO-WAY LOCK NUT — **for faster application with consistent torque**



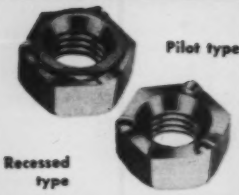
This all-metal, double chamfered, re-usable lock nut can be applied to bolt threads from either end. The center locking principle permits bolt end to be flush with top of nut.

M·F UNI-TORQUE LOCK NUT — **for high torque consistency in full and jam thickness**



This consistent-torque lock nut will withstand terrific vibration and shock loading; retains its locking ability for as many as 10 RE-applications.

M·F PROJECTION WELD NUT — **for low-cost assembly**



Solve production delays, cut manufacturing costs—fuse nut to the product in exact location. Engineered for assembly simplification. The welding of nuts to sub-assemblies permits the use of screws or bolts in the main assembly without the need for holding nuts from turning, cutting time and labor.

Both types available with the patented M·F Two-Way locking feature. Each type has three welding projections, eliminating rock and guaranteeing a uniform weld.

M·F SPIN LOCK NUT — **the nut with the built-in lockwasher**

This free-spinning one-piece lock nut eliminates the need for supplemental locking devices such as lockwashers. Cuts purchasing and inventory costs.

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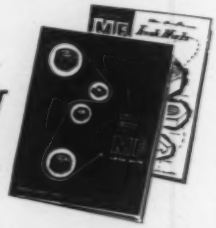

The M·F Products Catalog—valuable data on torque, bolt tension and dimensions as well as on other available products.

MAC LEAN-FOGG Lock Nut Company

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Circle 580 on Page 19

ard a guess that 40 per cent of the engineers are engaged in work which is almost completely outside the scope of any professional society.

Many engineers faced with this situation would rather spend time and money on more appropriate educational courses of specialized reading in their particular fields. However, I am convinced that if groups with common interests could be brought together and free interchange of ideas encouraged, much could be accomplished to advance their interests and knowledge.

I got the impression from your editorial that you were advocating conformism rather than individualism. This, unfortunately, appears to be the trend today. Perhaps we should remember more often that new ideas have usually come from an individual who was not willing to accept the acknowledged method of doing something, going out on his own to seek a new, unorthodox method.

In other fields, such as the arts, we recognize the individual effort. We do not measure an artist by the number of art colonies he has joined, nor do we say a doctor is a more conscientious doctor just because he belongs to the AMA. In short, let's not forget the individual effort and let's not set arbitrary standards of conformance.

—KENNETH L. SHEARER
Group Manager, Engineering Services
Chicago Aerial Industries Inc.
Melrose Park, Ill.

To the Editor:

Your editorial in the February 20 issue of MACHINE DESIGN has just come to my attention. You have stated the case here for professional societies much more eloquently than I have seen it stated in most instances.

Those of us who have been active in professional societies feel that we have benefited greatly by it and we appreciate your efforts to arouse a similar interest among those who have not been active.

—CHARLES E. CREDE
Vice President, Region I
The American Society of Mechanical Engineers

To the Editor:

Your editorial, "The Lone Wolf," in the February 20, 1958 issue of MACHINE DESIGN has been called to my attention by one of our members, and I agree with him that you have a rather fine story.

In view of the fact that we are going to have our convention in Cleveland on March 20 and also in view of the fact that I need literature of various kinds to distribute at board meetings, chapter meetings, etc., I am inclined to photo the page and run off 1000 copies on our offset press to use for various occasions of this kind as mentioned above. I hope you have no objections.

—LLOYD A. CHACEY
Executive Secretary
Ohio Society of Professional Engineers

To the Editor:

Again congratulations on this fine expression of the practical value of professional concepts.

Would it be possible to get reprints of this editorial for mailing to members of the Wisconsin Society of Professional Engineers, also a copy to be mailed with our membership brochure?

—E. C. KOERPER
President, Milwaukee Chapter
Wisconsin Society of Professional Engineers

MACHINE DESIGN can furnish reprints of the subject editorial at nominal cost in large quantities or will be happy to extend permission to reproduce it for distribution to interested groups.—ED.

They Say . . .

"Managers have the authority but not the knowledge; the specialists have the knowledge but not the authority. The difficulty manifests itself not in gross technical blunders or financial losses but rather in a tendency to avoid innovation or in what might be termed technical sluggishness." — MORROUGH P. O'BRIEN, *dean, College of Engineering, University of California, Berkeley, Calif.*

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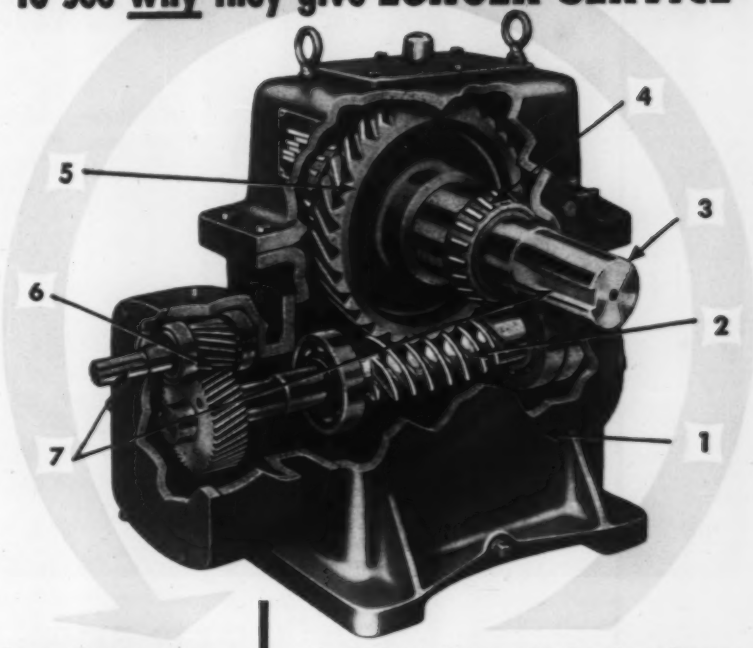
ENCLOSED WORM GEAR DRIVE

to see why they give LONGER SERVICE



1 EXTRA STRONG CAST HOUSING
Provides rigid mounting and alignment of caps and bearings. Made of high quality cast iron.

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Integral with oversize shaft. Carefully matched to worm gear for quiet, trouble-free service.

3 OVERSIZE OUTPUT SHAFT

4 HEAVY DUTY, EXTRA LARGE BEARINGS
Oversize bearings used throughout unit. Worm bearings are combination single row radial and angular contact ball bearings. Input shaft bearings are single row radial type.

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Shaved for full tooth contact. Pinion integral with input shaft. Gear locked in position on worm shaft extension.

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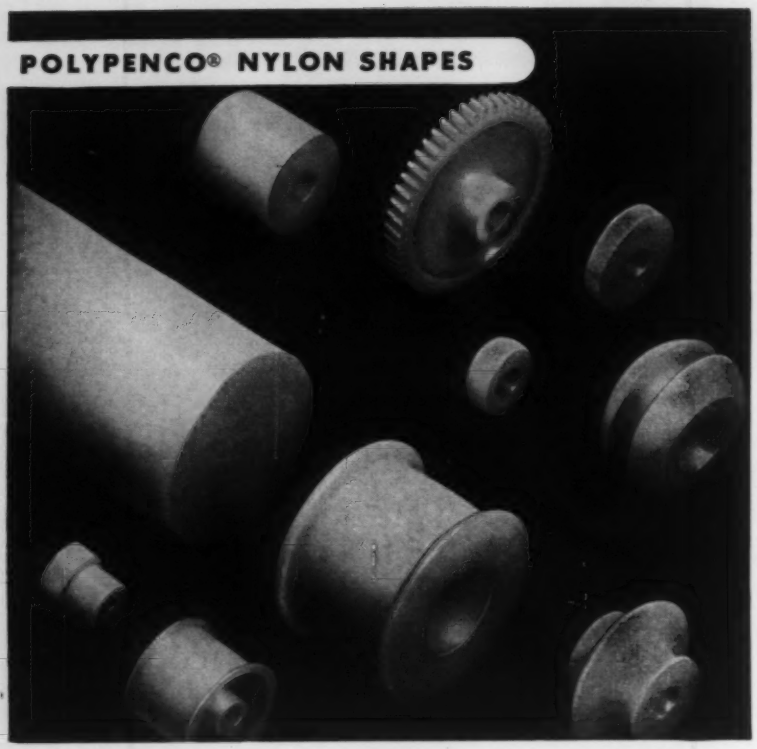
Circle 581 on Page 19

POLYPENCO® NYLON SHAPES



Practical, low-cost solution to nylon parts design: POLYPENCO Nylon Rod

ADAPTABLE Polypenco Nylon rod continues to be the choice of designers who require highest quality nylon *plus* rapid, low-cost production. From the complete range of sizes of Polypenco Nylon rod, it's a quick and economical step to fabricate close tolerance parts and components on standard metalworking tools. Bearings, rollers, thick gears and other parts machined from Polypenco rod have these outstanding properties:

- **Wear resistance**
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Polypenco Nylon stock shapes are also available in tubular bar, strip, tubing and plate and can be shipped immediately from warehouses located throughout the country. For fabrication of parts, The Polymer Corporation of Pa. maintains a special fabricating service. Write for data on products or services.

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THE ENGINEER'S Library

Recent Books

Feedback Control Systems. *By Otto J. M. Smith; 694 pages, 6 by 9 in., clothbound; published by McGraw-Hill Book Co. Inc., 330 West 42nd St., New York 36, N. Y.; available from* MACHINE DESIGN, *$13.50 postpaid.*

Here is a unified procedure for covering the analysis and design of all types of feedback systems. This book presents the relationship between the open-loop transient, sinusoidal, or statistical response, and the closed-loop transient, sinusoidal, and statistical responses. It is shown how from any one of these six responses, the other five can be computed.

Four major sections cover linear analysis, linear synthesis, steady-state nonlinear analysis, and nonlinear synthesis.

Mathematical Excursions. *By Helen G. Merrill; 145 pages, 5½ by 8 in., paperbound; published by and available from Dover Publications Inc., 920 Broadway, New York 10, N. Y.; $1.00 per copy.*

This book probes into elementary problem-solving by means of some entertaining by-paths not usually traveled in math courses.

Contents include methods of division and multiplication, treatise on squares, verification of formulas, facts about pi, and a discussion of the "impossible" in mathematics.

Radioisotopes, A New Tool for Industry. *By Sidney Jefferson; 110 pages, 5 by 7 in., clothbound; published by and available from Philosophical Library Inc., 15 East 40th St., New York 16, N. Y.; $4.75 per copy.*

Applications and advantages of radioisotopes in industry are covered in this book. Included are nontechnical discussions on methods of determining thickness of materials, coatings, and plating.

Topics include suggested applica-

tions of radioisotopes for inspecting welds, radiographic interpretation, and fundamentals of radioactivity.

Vibration Control. *By John N. MacDuff and John R. Curreri; 465 pages, 6 by 9 in., clothbound; published by McGraw-Hill Book Co. Inc., 330 West 42nd St., New York 36, N. Y.; available from* MACHINE DESIGN, *$9.00 postpaid.*

This book, written for practicing mechanical engineers and designers, deals with fundamentals of vibration control. Methods of analysis for classical vibrating systems are developed. Systems of interest to designers are emphasized.

Included are elementary differential equations, impedance method for steady-state vibration, operational calculus and electronic computer methods for transient analysis, and methods for analyzing nonlinear systems.

Management for Engineers. *By Roger C. Heimer; 453 pages, 6 by 9 in., clothbound; published by McGraw-Hill Book Co. Inc., 330 West 42nd St., New York 36, N. Y.; available from* MACHINE DESIGN, *$6.75 postpaid.*

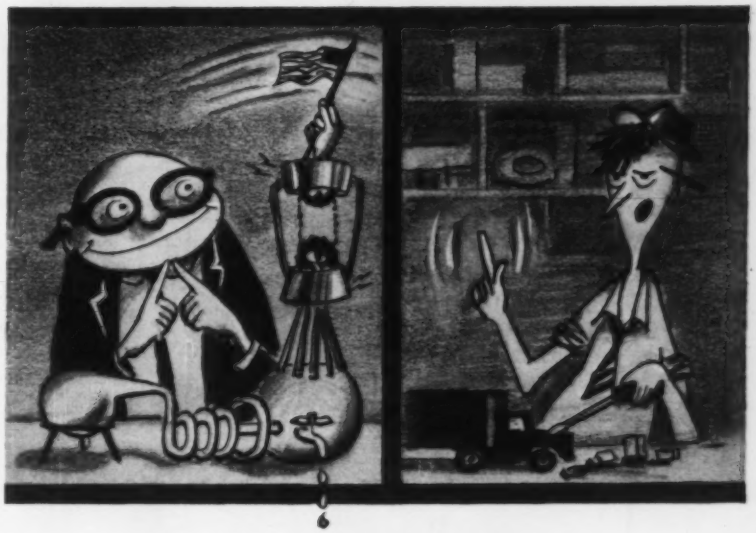
The purpose of this book is to familiarize engineers with management decision-making processes. It sets forth day-by-day workings of a business firm both as an economic institution and as a co-ordinate organization of individuals. It considers the impact of costs, standards, equipment, and ethics upon engineering decisions.

Topics include the professional engineer defined, engineering ethics, professional recognition, organization purposes, partnerships, contracts and policies, operating standards, line and staff objectives, and prerequisites to decision making.

The Metallurgy of Vanadium. *By William Rostoker; 185 pages, 6 by 9 in., clothbound; published by John Wiley & Sons Inc., 440 Fourth Ave., New York 16, N. Y.; available from* MACHINE DESIGN, *$8.50 postpaid.*

This book discusses the extraction, processing, and formability of vanadium and describes the state of the art of vanadium alloying.

Included are physical and mechanical properties of the metal and its alloys, forming methods, oxida-

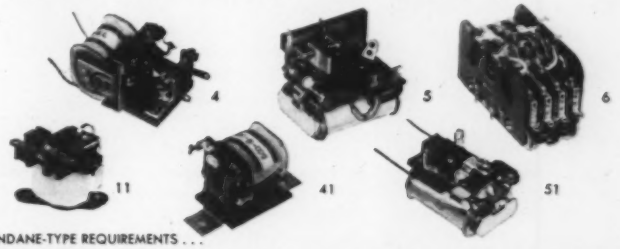


SIGMA TYPES AT YOUR SERVICE

On the left, Hardwicke J. von Cumulus exemplifies scientific inquiry in the best tradition, pondering problems of the highest order concerning interrelation of theoretical factors in sensitive relay design. His is an 0.6^{-13} world, beyond the ken of most, deaf to the Cry of the Coliseum. He's the gentleman to see if you're just wondering about the characteristics of a relay for use somewhere out of this world.

At right is Sigma's General Purpose Application Man of the Year, Mackinaw L. Mundane. Although Mackinaw will never quite understand what all the Hardwickes are muttering about, he doesn't care; he's closing in fast on some good unsophisticated jobs for Sigma relays. He's heard all about Progress, Improvement and Doing the Difficult Jobs Well, but he knows *his* bread is buttered by the guy who wants a relay that will work well, on the ground, under everyday circumstances. He will enthusiastically tell you, point blank, which Sigma type to pick for speed, quietness, price, life or some combination thereof. His customers make toys, burglar alarms, electric blanket controls, machinery controls, UL-approved items and such, and some of his favorite relays are shown below.

Actually, there's a whole crew of Mundanes here ready to jump when you speak — not at you, but up with answers. Or from a distance you can get some useful data on which to judge and select, in the form of specific relay Bulletins, or assembled within elegant covers as the NEW Sigma Catalog. Communication with H. J. von C. and other Scientists, however, is restricted to 8:30-5:00, Monday through Friday.



AMONG MUNDANE-TYPE REQUIREMENTS . . .

LOW PRICE: Series 11 sells at less than a dollar in quantity, with mechanical life of 100,000,000 operations. DC and shaded pole AC.

RANGE OF ADJUSTMENT: Series 4 and 5 can be adjusted and specified as to both drop-out and pull-on. Standard sensitivities from 1 to 200 mw.

HIGH CONTACT RATING: Series 51 switches 10 amperes of incandescent lamp load yet operates on 100 mw.

HIGH SPEED: Series 41 can be operated in less than 2 milliseconds and will switch loads up to 1 ampere 100,000,000 times.

AC OPERATED: Shaded pole 41 with no rectifiers. Extremely quiet, reliable operation with switch ratings up to 5 amperes, or operating sensitivity as low as 0.06 v-a.

MAGNETIC LATCHING: Series 6 (Form Z) polar relay provides an exceptionally reliable latching contactor. Up to 4-pole double throw with no mechanical catches to wear.

SIGMA

SIGMA INSTRUMENTS, INC.
89 Pearl Street, So. Braintree 85, Massachusetts

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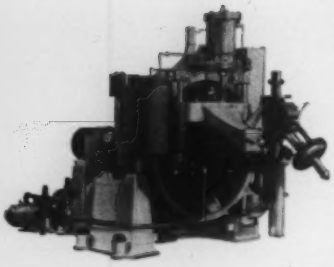

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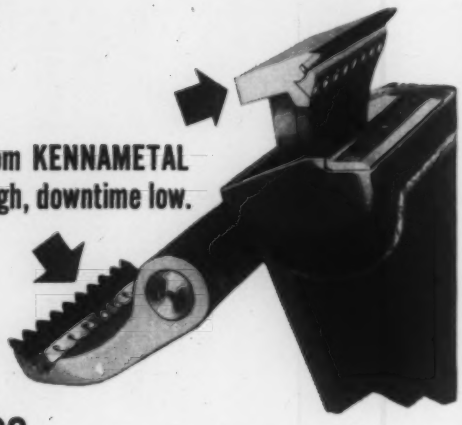
More than 400 of these centrifuges are now in service, with a combined daily capacity in excess of 1,600,000 cubic feet.



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Against $(NH_4)_2SO_4$

KENNAMETAL* components last 2 to 6 times longer . . .

On Unloader Knives: When processing corrosive Ammonium Sulfate (Coke Plant), the best life of any material tried for unloader knives on this crystal dehydrator was less than three months.† With Synthetic Ammonium Sulfate, the knives lasted little more than a month. By changing to knives made from Kennametal hard tungsten carbide, service life has been increased to twelve months or more with Coke Plant Sulfate, and up to four months with Synthetic Sulfate.

On Distributor Tips: With sulfates of either kind, Kennametal Distributor Tips in the feed assembly last up to eight months —double the life of any other alloys tried. Kennametal parts cost less in terms of longer life, increased production, and less downtime.

Chances are Kennametal can help *you* solve a problem involving corrosion, abrasion, erosion, or contamination. The Kennametal "family" of hard carbides includes grades three times as rigid as steel . . . grades that last up to 60 times as long as steel . . . grades that retain high strength at 2200°F and above or at subzero temperatures.

Let us tell you more about Kennametal and how it has helped others solve problems that may be similar to yours. Write to KENNAMETAL INC., Dept. MD, Latrobe, Pennsylvania.

*Trademark
†Based on an average daily throughput of 100-150 tons.

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tion and corrosion data, and metallography of vanadium. A section of the book deals with effects of vanadium additions on steels, cast iron, titanium, magnetic alloys, and high-temperature alloys.

New Standards

ASTM Standards on Refractory Materials. *414 pages, 6 by 9 in., paper or clothbound; published by and available from American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa.; $5.50 per copy paperbound, $6.25 cloth cover.*

This manual presents all 41 ASTM specifications, classifications, methods of testing, definitions, and suggested procedures related to refractories. In addition, there is a proposed glossary of terms relating to refractories, their manufacture and use. Included also are surveys on refractory service conditions relating to the production of steel, cast iron, coke, copper, lead, portland cement, lime, and glass.

Association Publications

Proceedings of the Second Nuclear Engineering and Science Conference, Volumes 1 and 2, Advances in Nuclear Engineering. *Edited by John R. Dunning and Bruce R. Prentice; 1104 pages, 8½ by 11 in., clothbound; available from American Society of Mechanical Engineers, 29 West 39th St., New York 18, N. Y.; $35.00 per set; most articles available in single-copy format at 30 cents per copy.*

These volumes contain papers presented at the 1957 Nuclear Congress held in Philadelphia. They represent a collection of current information on nuclear reactors, and their design, construction, and operation.

Volume 1 contains discussions concerning fuel cycles, plant containment concepts and design, plant components, waste disposal, protection and safety measures, and radiation processing.

Volume 2 contains discussions on reactor design, core design, educational use of reactors, metallurgy, natural resources, instrumentation, and standardization.

ASTM Special Technical Publications. *Each booklet 6 by 9 in., hard cover; published by and available from American*

Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa.

The following booklets are available:

STP No. 213 Symposium on Nondestructive Testing—104 pages; $2.75 per copy.

STP No. 203 Fatigue of Aircraft Structure—104 pages; $2.75 per copy.

Manufacturers' Publications

Sheet and Plate Product Information. (*Aluminum*). 308 *pages, 5 by 8¼ in., clothbound; available from Technical Editor, Kaiser Aluminum & Chemical Sales Inc., 919 North Michigan Ave., Chicago 11, Ill.; free if requested on company letterhead; $5.00 per copy for personal libraries.*

This book describes aluminum and its alloys, their availability, and the metal's physical and chemical properties. It also discusses criteria of selection for aluminum sheet and plate alloys for specific applications. Alloys are evaluated in terms of formability, machinability, and weldability.

Major topics include preparation of aluminum for fabrication, methods of forming and joining, adhesive bonding, and surface finishes.

Stainless Steel Fabrication. 386 *pages, 8 by 10½ in., clothbound; available on letterhead request from Allegheny Ludlum Steel Corp., Pittsburgh 22, Pa.*

This book is intended as a guide to the selection and application of stainless steels. It covers common methods and practices required for fabrication and discusses precautions and treatments necessary to realize the inherent properties of stainless.

Main topics include considerations of stainless-steel properties in relation to design, operations required for fabricating finished parts, and procedures necessary to prepare surfaces for various treatments and finishes.

Engineering Data on Thread and Form Rolling. 87 *pages, 8½ by 11 in., paperbound; available from Reed Rolled Thread Die Co., Worcester 1, Mass.; $1.50 per copy.*

This third edition has been revised to include recently compiled data on thread and form rolling. It covers selection of rolled-thread fasteners for high-temperature and high-pressure applications, tolerance

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New flexible printed wiring sharply reduces weight, bulk and cost of electronic and electrical assemblies.

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MEASURE ONLY:
1½" x 1½" x 1⅜"

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limits and allowances, specifications, and standards.

Also included are a discussion of rollability of various materials, machinability ratings of carbon and alloy steels, and specification criteria for blanks.

Permanent Magnet Handbook. *Edited by Earl M. Underhill; 380 pages, looseleaf form, 6 by 9 in., plastic bound; available from Crucible Steel Co. of America, Advertising and Promotion, Pittsburgh 30, Pa.; $10.00 per copy.*

This handbook is devoted to reporting current developments in permanent magnets. Supplemental sheets containing data on new magnet materials and details of permanent magnet design will be issued periodically at no extra cost to registered holders of the handbook.

Twelve color-coded sections cover developments of permanent magnets, magnet design and measurements, theories of ferromagnetism and electromagnetism, selection of permanent-magnet steels and other alloys, standard and stock magnets, and design specifications and data.

Copper and Copper-Alloy Specifications Index. *27 pages, 8½ by 11 in., paperbound; available on letterhead request from The American Brass Co., Waterbury 20, Conn.*

Three major sections of this booklet cover applications of copper and copper alloys, government and engineering society specifications which the alloys satisfy, and compositions of all alloys covered by specifications. Coverage includes leaded and special brasses; phosphor, aluminum, and cadmium bronzes; cupro nickels; and nickel silvers.

Government Publications

An Evaluation of Fatigue Properties of Titanium and Titanium Alloys, PB 121631. *By J. G. Weinberg and I. E. Hanna; 108 pages, 8½ by 11 in., paperbound; available from Office of Technical Services, U. S. Dept. of Commerce, Washington 25, D. C.; $3.75 per copy.*

This report summarizes the current status of fatigue properties of commercially pure titanium and of various commercial titanium alloys.

Fatigue behavior of titanium is discussed relative to unnotched

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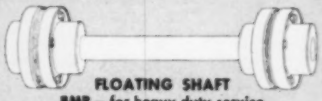

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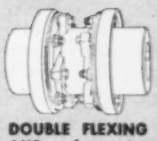

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fatigue strength, effects of notches, effect of surface preparation, metallurgical influences, and effects of temperature.

Investigations of Materials Fatigue Problems, PB 131288. *By H. N. Cummings, F. B. Stulen, and W. C. Schultz, all of Curtiss-Wright Corp.; 208 pages, 8½ by 11 in., paperbound; available from Office of Technical Services, U. S. Dept. of Commerce, Washington 25, D. C.; $5.50 per copy.*

This report contains results of fatigue tests conducted on various air - melted and vacuum - melted steels. Relationship of nonmetallic inclusions to fatigue life and strength of the steels is included.

Materials discussed include SAE 4340 steel and 52100 ball-bearing steel. Tests cover effects of inclusions in smooth and notched specimens, effects of fine surface finishes on vacuum-melted alloys, and effects of shape on fatigue properties.

OTS Research Reports. *Each publication is 8½ by 11 in., paperbound, and stapled; copies are available from Office of Technical Services, U. S. Dept. of Commerce, Washington 25, D. C.*

The following reports are available:

Fatigue Investigation on High-Strength Steel, PB 131371. By J. K. Childs and M. M. Lemcoe, Southwest Research Institute; 37 *pages*, $1.25 *per copy.*

Alloys of Aluminum, Thorium, and Uranium, ISC-832. By G. E. Bobeck and H. A. Wilhelm, Ames Laboratory; 26 *pages*, $1.00 *per copy.*

High Temperature Protective Coatings for Magnesium, PB 131073. *By C. R. Fitzgibbon, E. H. Miller, and M. A. Glaser, Midland Industrial Finishes Co.; 112 pages, 8 by 10½ in., paperbound; available from Office of Technical Services, U. S. Department of Commerce, Washington 25, D. C.; $3.00 per copy.*

This report discusses the work performed in the development of three air-drying coating systems for magnesium. The new coatings have film properties equal to or better than present air-drying finishing systems for this metal, and withstand temperatures to 500 F.

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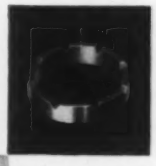

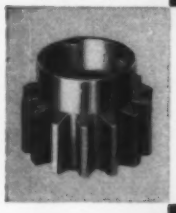

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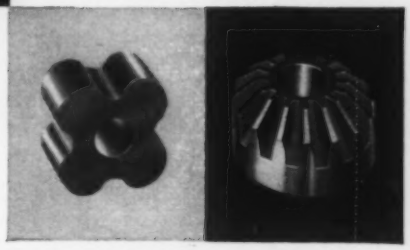

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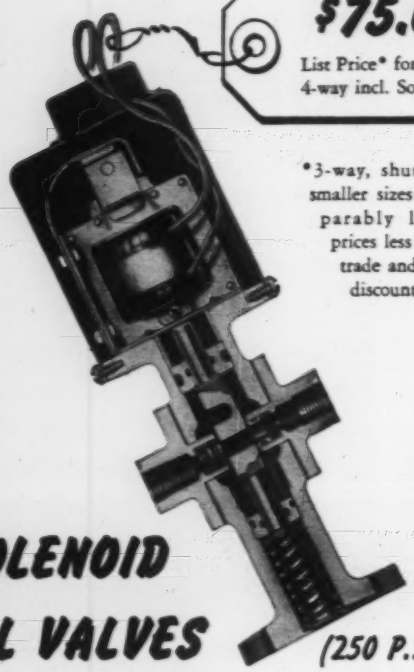

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Machine tool chucking & clamping	Maintaining safe holding pressure (leakproof)	Saving auxiliary equipment such as pilot operated check valves
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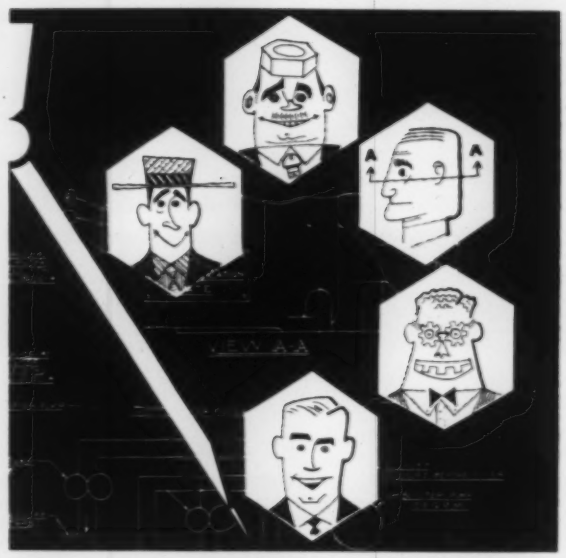
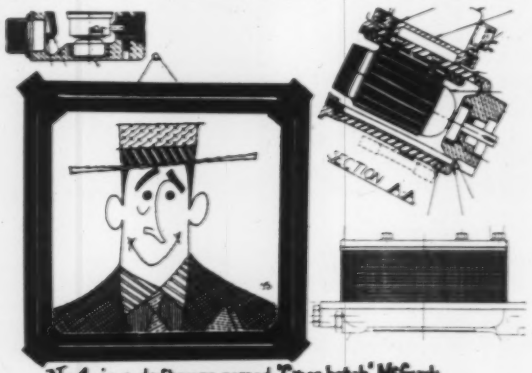
Stress Relief

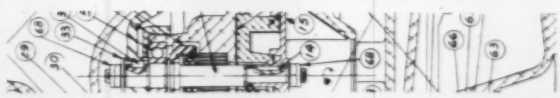
COMMON sense in drafting pays off, according to the plot of the following story which originally appeared as a booklet for internal use at Borg-Warner's Pesco Products Div., Cleveland. Ideas for the booklet came from Richard A. Powley, president of Pesco. The Jayme Organization Inc. prepared the booklet under the direction of John D. Stoia, art director.



Here's a line-up of guys from the draftsman's "Who's Who" (Don't be surprised if one **should** sound like **you!**)



No. 1 is a draftsman named "Cross-hatch" McGurk
Who loved to put patterns in all of his work
Much more than was needed, he'd stipple and line –
He'd fill every inch with diagonals fine.
He'd spend blissful hours, ignoring the cost;
In a loud maze of patterns, all the drawing was lost!



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LAMSON PLUG NUTS

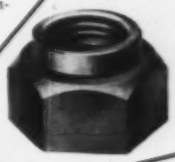
These are usually used in situations where a fastening is made from one side of the work. The Plug Nut is inserted in a hole prior to putting the parts to be assembled together. A bolt, inserted through a matching hole in the second part to be assembled, engages the threads of the nut to complete the assembly.

STOVER LOCK NUTS

These lock nuts operate on the principle of distorting the upper part of the nut from true round. As the nut tightens on the bolt, this distortion grips the bolt with a locking action.

LAMSON LOCK NUTS

This is an all-steel lock nut that gets its locking action from a special collar, distorted from the round. This grips the threads of the bolt as it is tightened down. Nut can be backed off with a wrench and re-used.



SEMS

Sems are pre-assembled screws and washers. The washer cannot come off because the threads are rolled on the screw after washer is on. Many different types of screws, heads and lock washers are available.

SAFE-LINE CLAMP

This wire rope clamp is made in three parts as shown. The two mating parts grip the lay of the rope as the nut is tightened down. The holding power of the clamp matches the strength of the rope itself.

SPIN-LOCK SCREWS

These fasteners have a ratchet-like structure below the head that bites into the metal and holds the screw from "backing off" once the screw is tightened. They come in a wide variety of head types and sizes.

ALUMINUM ALLOY FASTENERS

These are available in many types, sizes and shapes.

HOOK KNURL BOLTS

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Studs and bolts with the Lok-Thred feature are used primarily where severe vibration occurs or sealing action is desired. The alteration in the thread form causes the Lok-Thred to re-form the socket thread. This places the metal of the socket thread under stress giving a locking action.

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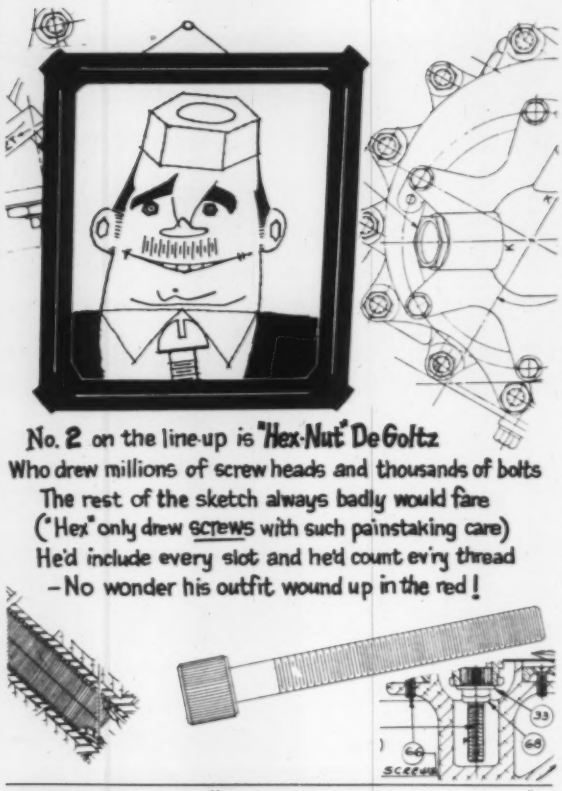
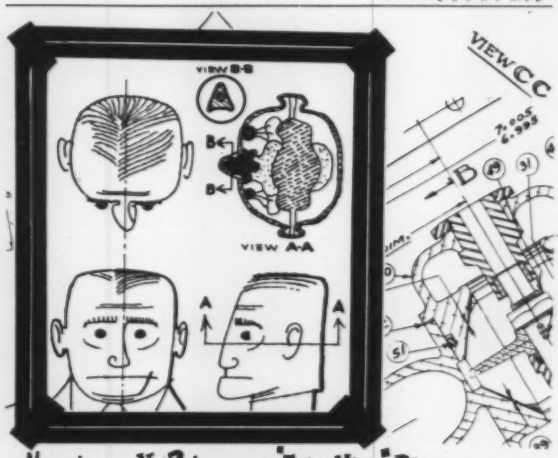
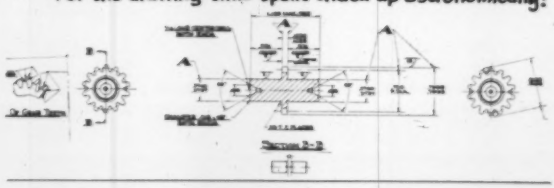
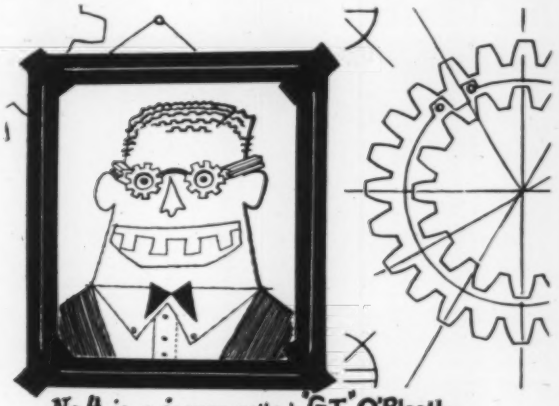


No. 2 on the line-up is "Hex-Nut" DeGoltz
Who drew millions of screw heads and thousands of bolts
The rest of the sketch always badly would fare
("Hex" only drew screws with such painstaking care)
He'd include every slot and he'd count ev'ry thread
– No wonder his outfit wound up in the red!

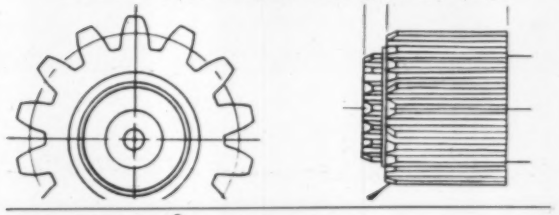


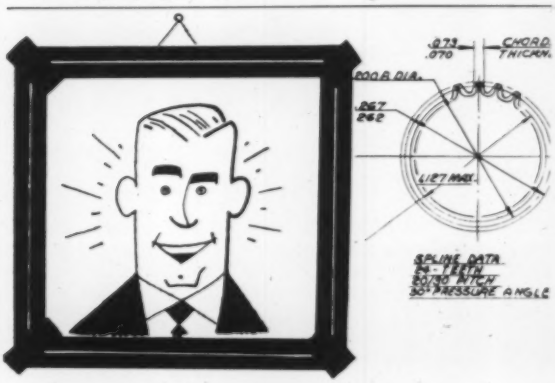
Now here's No. 3, known as "Extra View" Bloo
Who never showed two views when five views would do.
(In fact, when inspired, a sketch he'd imbue
with a sectional view of a sectional view!)
Though fine works of art, they were flops economically
For the drawing time spent ended up astronomically!



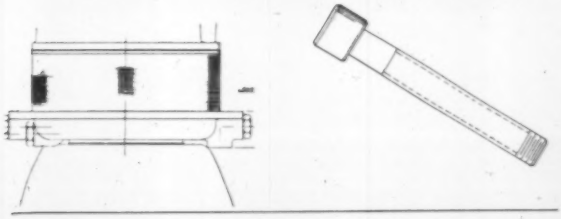


No. 4 is a jasper called "G.I." O'Bleeth:
A draftsman who reveled in drawing gear teeth
If a hundred were called for, a hundred he drew,
Rather than showing just a representative few
and then naming the number; this made too much sense
So, the devil with logic, and hang the expense!





And last, No. 5, Hero "Short-Cut" McGarrity
Who wanted to draw with exactness and clarity
His drawings were clear and concise; less abundant
No confusing details and no patterns redundant
If you think Mac's approach was no more than a whim
– the other four guys are now working for him!



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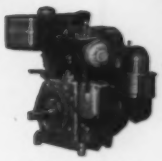

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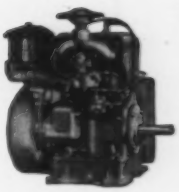

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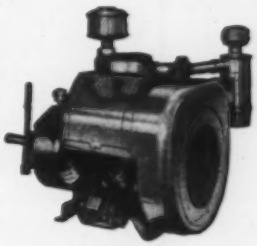

V-type 4-cyl. 15 to 56 hp.

Here is complete power selectivity *tailored to the job and the equipment*. But of even greater importance are such features as heavy-duty design and construction; traditional high quality in all details; load-lugging high-torque performance and dependable all-weather AIR-COOLING from low sub-zero to 140° F. . . . *plus* exclusive specialization in the manufacture of air-cooled engines, backed by more than 2,000 Approved Service Stations.

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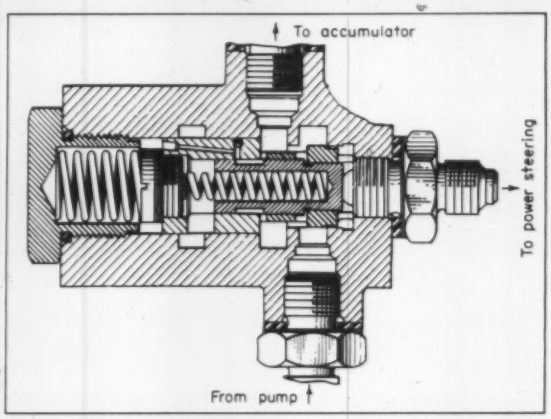
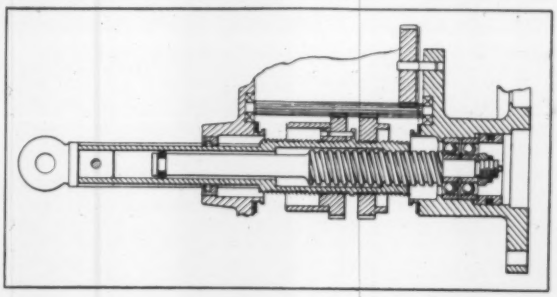


is in an automotive power-steering system where the power-steering mechanism cannot be allowed to starve during the accumulator loading cycle. Under normal steering-load demands, the priority valve diverts approximately 50 cent of the pump flow to the accumulator and 50 per cent to the power-steering motor. Should steering demand increase radically during the accumulator loading cycle, the priority-valve plunger shifts, directing the entire pump output to the steering motor. *Patent 2,818,711 assigned to General Motors Corp., Detroit, Mich., by Clovis W. Lincoln, Joseph J. Verbrugge, and Philip B. Zeigler.*

Linear Actuator

Power-operated limit stops in a linear actuator allow end points of extension and retraction strokes to be remotely set. Stop nuts, which are threaded internally right and left hand, are provided with external gear teeth in mesh with a common pinion rod. When pinion rod rotates, stop nuts traverse in opposite directions, shifting the end points of actuator motion. *Patent*



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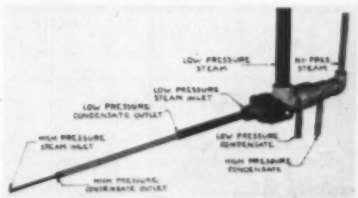

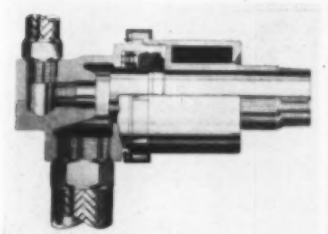

Self Supporting

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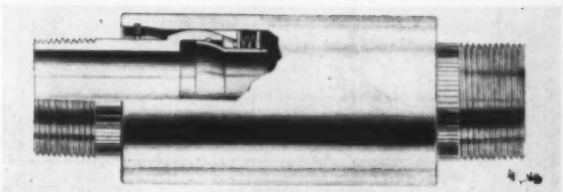


WRITE FOR EXPANSION JOINT CATALOGUE

ROTHERM ENGINEERING COMPANY, INC.

7280 DEVON AVE., CHICAGO 31, ILLINOIS

SEE US AT DESIGN ENGINEERING SHOW

Circle 595 on Page 19

AUTOMATIC PRESSURE or VACUUM CONTROL J6

UE TYPE **J6 PRESSURE & VACUUM CONTROL**

UNITED ELECTRIC TYPE J6 unit is designed to automatically control either pressure or vacuum . . . has a fixed, uniform on-off differential as specified between limits of 3" WC to 2 PSI . . . and a maximum controlling pressure of 180 PSI. It is a sensitive, weatherproof, precision built control with good repeatability. Recommended for all pressure or vacuum applications which require close on-off differential control.

Switch Differential	Fixed as specified between limits of 3" WC to 2 PSI.
Switch Ratings	15 or 20 amps at 115 or 230 volts AC, also DC switches upon specification.
Switch Types	N.O., N.C., or Double Throw, no neutral position.
Size	4¾" x 4 27/32" x 2 5/16".
Weight	Approx. 1 lb. 8 oz.
Electrical Connection	½" NPT conduit opening in enclosure, screw type terminals on switch is standard.
Enclosure	Die-cast aluminum case, black wrinkle finish standard.
Mounting	Surface mounted—by 2 mounting ears.
Bellows	Seamless brass—spring loaded.
Pressure Connection	¼" NPT female connection.

UNITED ELECTRIC *manufactures a complete line of temperature, pressure and vacuum controls. UE will gladly modify or custom-build a unit to your specifications. Consult a UE application engineer today.*

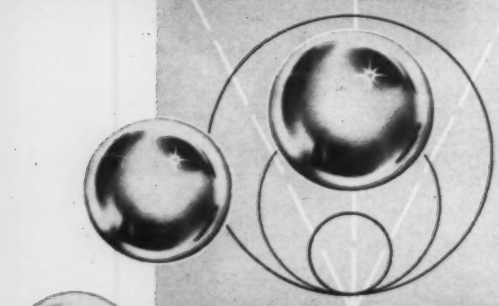
Write for Bulletin No. 5-3 for complete J6 data.

United Electric Controls COMPANY

89 SCHOOL STREET, WATERTOWN, MASS

Circle 596 on Page 19

THE EASY WAY
to get fast service on
Precision Balls



just contact your nearest direct HSB representative

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Special Materials

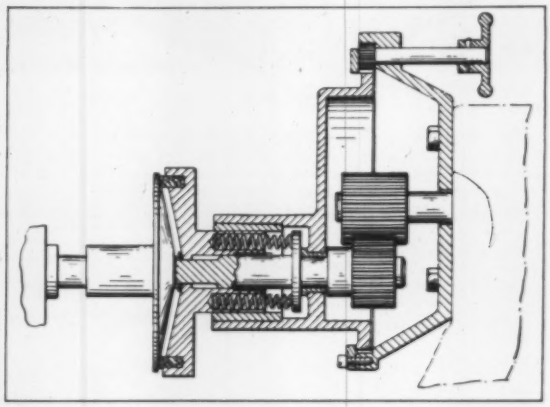
Hartford
PRECISION BALLS • BEARINGS

Hartford Steel Ball Co., Inc.,
93 Jefferson Avenue, W. Hartford 6, Conn.

2,818,744 *assigned to Lear Inc., Grand Rapids, Mich., by Steven M. Moody.*

Adjustable-Speed Drive

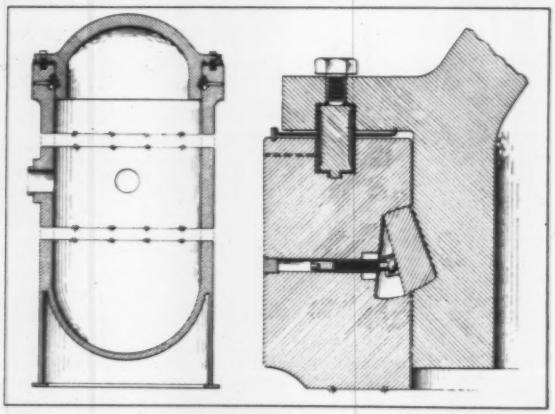
Speed ratio of an adjustable-speed drive is altered by changing the radius of contact of friction-coupled driving and driven members. When the drive mechanism is in the configuration shown here, axes of drive



cone and annular friction ring are coaxial and ratio between input and output shaft speeds is 1:1. When the housing of the unit is rotated by means of the handwheel (upper right), the shaft carrying the friction ring translates with respect to the drive-cone shaft and the ring contacts the cone at a reduced radius. Result is to give a step-down ratio between input and output shaft speeds. *Patent 2,818,740 assigned to Murray Co. of Texas, Dallas, by Emil S. Wuertz, Quincy, Mass.*

Pressure-Vessel Closure

Pivoted segments, extended and withdrawn by actuator screws, provide a secure closure for pressure-vessel access openings. When segments are flush against the



pressure-vessel wall, access-door cover can be easily withdrawn. When extended, the locking segments secure the door against pressures exceeding 2000 psi. *Patent 2,822,109 assigned to Combustion Engineering Inc. by Einar E. Tangard, Scarsdale, N. Y.*

Circle 597 on Page 19

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ENGINEER'S FACT FILE

A Complete Reference Manual on

MERCURY PLUNGER RELAYS

For all loads up to 60 AMPS or 5 HP.

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Solves your relay problems once and for all

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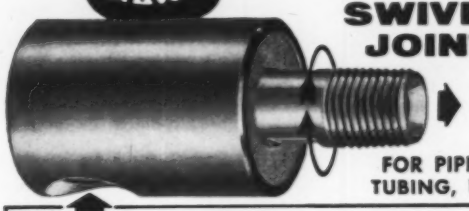
Circle 598 on Page 19

THE ANSWER when You Need Flexible Connections!

BARCO

NEW SINGLE PLANE
SWIVEL JOINT



FOR PIPING, TUBING, HOSE

For Hydraulic or Pneumatic Service

Here is the *brand new* BARCO SINGLE PLANE SWIVEL JOINT that swivels in one plane only. Now offered by Barco to meet the needs of innumerable design engineers and machinery builders:

- **Key to Better Engineering!** Small, light, inexpensive. Very low torque under pressure. Neat, space-saving installations. Easy to position lines accurately.
- **Many Uses:** (1) To make piping or tubing movable, flexible! (2) As swivel connectors on hose to eliminate torsional working stresses and long radius bends. Longer hose life! Shorter lengths required!
- **Sealed, Unitized Construction.** Built with ball-bearing or thrust bearing. O-ring seal. Choice of styles; sizes ¼", ⅜", ½", ¾". For service to 2,000 psi, −20° to 225°F. Other types available for higher ratings. *Ask for Catalog Sheet 406.*

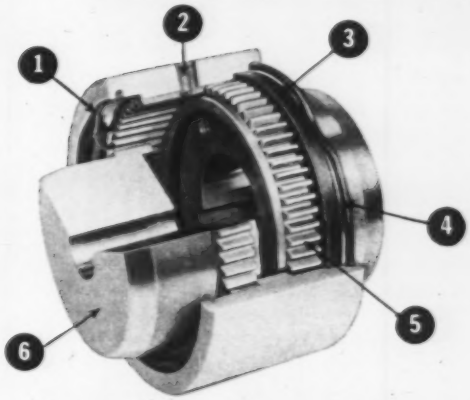
BARCO MANUFACTURING COMPANY
506-E Hough Street • Barrington, Illinois

Circle 599 on Page 19

the "INSIDE STORY" of why

Sier-Bath FLEXIBLE GEAR COUPLINGS

are your best buy!



Simplicity is the answer.
Sier-Bath's one piece sleeve eliminates heavy flanges and bolts found on other couplings, cuts weight in half, decreases size by three-fifths, increases horsepower capacity. The result? Lighter, more compact equipment design . . . reduced power consumption . . . less wear . . . no freeze-up due to corrosion . . . no special tool problems . . . increased safety . . . long, trouble-free life at lower costs.

1. STEEL SLEEVE is one piece. Internal teeth run full working length. Geared sleeve connects the two hubs and transmits load from driver to driven shaft; there are no flanges and bolts.
2. GREASE PLUGS are set at 180°, providing simple method of relubrication without necessity of dis-assembly.
3. SEALS are made of neoprene and asbestos. Seal interior against foreign matter and retain lubricant. Seals are Johns-Manville "Clipper Seals" guaranteed for 400° F.
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5. GEAR TEETH are evenly and closely spaced, precision cut with minimum backlash. Smaller for even distribution of load, greater capacity and longer life.
6. STEEL HUBS are externally geared. Made of steel forgings with 90,000 lbs. tensile strength.

44 finished, standard bore sizes and a complete line of rough bores are available for immediate delivery from factory or distributor stocks. Send for the new Catalog C-5

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FLEXIBLE COUPLING DIVISION
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Circle 600 on Page 19

push-pull CONTROLS

Compression & Tension Type

Aircraft cable is strung with spherical steel shells in a rigid or flexible housing sealed with "O" rings. 3" standard bend radius. ¾" minimum bend radius.

Three Types:

1. *Light Duty*—Compression Ult. Load 1250 lbs.; Ult. tension 960 lbs.
2. *Heavy Duty*—Compression Ult. Load 1650 lbs.; Ult. tension 960 lbs.
3. *Extra Heavy Duty*—Compression Ult. Load 3050 lbs.; Ult. tension 3900 lbs.

Positive remote controls for actuating mechanical, hydraulic or other devices. Eliminate bell cranks, pulleys and dual cables. Patented U. S. A. All world rights reserved. Send for ENGINEERING MANUAL giving detailed prints and complete specifications covering materials, finishes, capacities. Please address Dept. MD-58.

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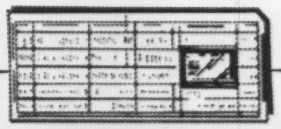
1705 SO. MOUNTAIN AVE., MONROVIA, CALIFORNIA

Circle 601 on Page 19



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Circle 602 on Page 19

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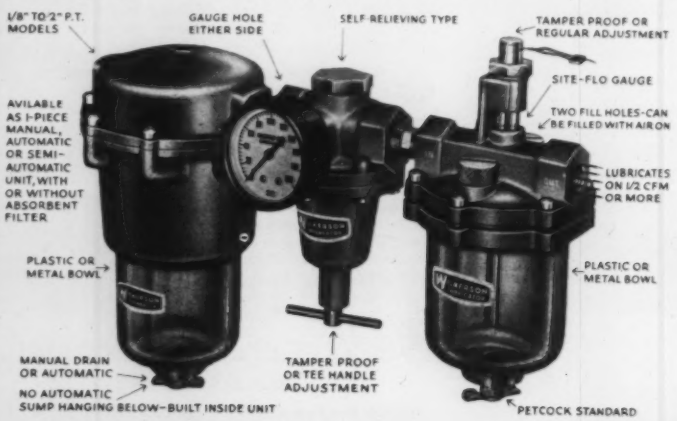
UNIT COMBINATIONS IN VARIOUS SIZES FOR ALL INDUSTRIAL USES

WILKERSON unit combinations are grouped for quick, easy installations in the compressed air system to provide "full control" of all air supplied to tools and equipment. The fully automatic operation of these control packages assures you of positive moisture and contaminant separation, accurate pressure control, and the proper lubrication of your equipment, with a minimum amount of attention. The representative group shown is Model No. 62060-4, composed of "FLO-KLEEN" Separator, "DIATROL" Regulator, and "ATOMIZER" Lubricator.

Groups featuring automatic draining or semi-automatic draining separators in combination with regulators and lubricators, are shown in New Combination Catalog No. 571. Write for your copy now. Investigate Our Complete Line of Automatic Air Products. Watch for following ads featuring other units.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PLASTIC OR METAL BOWL
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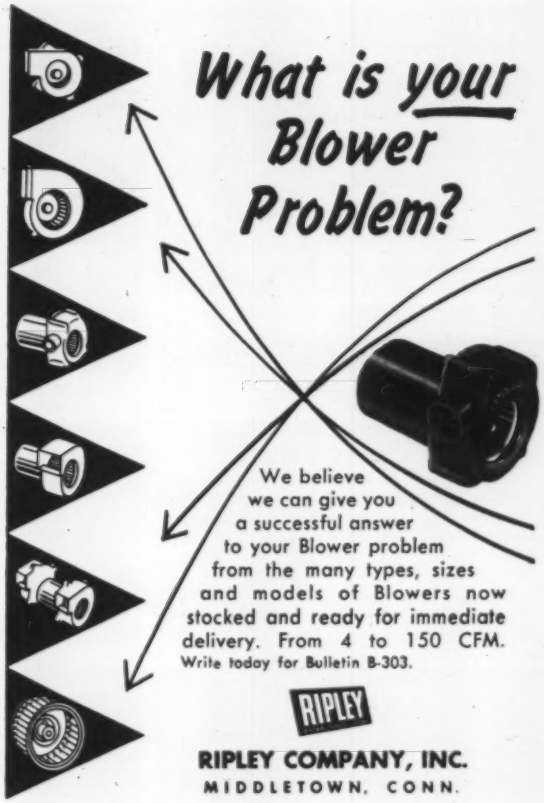
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We believe we can give you a successful answer to your Blower problem from the many types, sizes and models of Blowers now stocked and ready for immediate delivery. From 4 to 150 CFM.
Write today for Bulletin B-303.
RIPLEY
RIPLEY COMPANY, INC.
MIDDLETOWN, CONN.

Circle 604 on Page 19

Circle 605 on Page 19

Now... automatically apply standard socket set screws

SPEED SMALL PARTS ASSEMBLY

Here's the fastest way to insert and drive *standard* Bristol socket set screws . . . screws are inserted and driven at an average rate of 1800† per hour!

Just load hopper with socket set screws. Automatically they're positioned correctly and fed to the bit of the power screwdriver. Then they're inserted in tapped hole and tightened to predetermined torque or depth setting.

Fast Production. . . of set-screw fastened parts like pulleys, impellers, fan blades, knobs, collars, gear sprockets, bearings, cams, dogs, couplings and cranks.

No special screws required. Takes standard Bristol Hex or Multiple-Spline socket; cup, flat, oval, cone or half-dog point.

Uniform torque settings. Drives all screws to same (easily adjusted) pre-set depth or torque.

Reduces operator fatigue. Stops floor loss of screws. Eliminates cross-threading. Quick change-over for different sizes. Reduces floor area needed for assembly.

Get complete data on this outstanding mass production tool today. Write to the Application Engineering Department, Socket Screw Division, at the address below.

†Assembly speed varies with factors such as time required to present parts, screw thread pitch, length of screw, and depth of insertion.

A. B. 4

Precision socket screw manufacturers since 1913
Bristol's Hex Socket Screws
Bristol's Multiple-Spline Socket Screws
*Made in sizes as small as No. 0 in Alloy Steel and Stainless Steel. Cap screws up to 1½" diam.
THE BRISTOL COMPANY Socket Screw Division Waterbury 20, Conn.

See our exhibit in Booth 105 at the Design Engineering Show
See our exhibit in Booth 1447 at the ASTE Show

Circle 606 on Page 19

if you have a bearing problem,

here is your answer...

You can solve your bearing problems in the research and development stages or on the assembly line by specifying custom-fabricated Flexible Bearings by Bushings, Inc.

For when you design Flexible Bearings by Bushings, Inc. IN as original equipment you design noise, shaft-wear, vibration, shock and misalignment OUT.

Flexible Bearings by Bushings, Inc. have a mechanical bond between the flexing medium and the inner and outer members. They are available in two types: TORSIONAL for oscillating movement; PROTECTIVE for insulating solid bearings against load, sudden shock, misalignment and noise transmission.

Flexible Bearings by Bushings, Inc. are custom-fabricated to YOUR specifications—to do the job you want done.

So, for fast, authoritative engineering help on your bearing problems or needs—on the production line or the drafting board—write Harvey G. Moore at the address below.

For more than 15 years Bushings, Inc. has custom-fabricated bearings in a wide range of metals and sizes for hundreds of different manufacturers.

VIBRO-LEVELER MOUNTS dampen vibration, permit precision leveling of machines.

SILENT-LIGN PILLOW BLOCKS for shaft mounting. Has all Flexible Bearing features.

Bushings, Inc.

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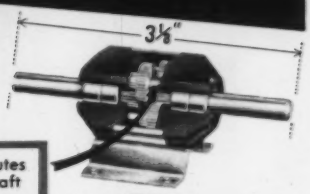
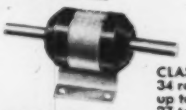
Metron Anti-Backlash SPEED REDUCERS

- Small in size
- Ready-to-go in your product
- Quick delivery



- Backlash only 15 minutes or less at lowspeed shaft
- Speeds up to 10,000 rpm at highspeed shaft
- Up to .013 HP at lowspeed shaft



CLASS A—34 ratios up to 27 to 1

CLASS B—49 ratios up to 729 to 1

CLASS C—122 ratios up to 19,683 to 1

CLASS D—232 ratios up to 531,441 to 1 (not shown)

Save on your design, production, and assembly costs by ordering these ready-to-go miniature components for your product.

WRITE *for Bulletin* **#100**

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DISTRICT OFFICES • NEW YORK • CHICAGO

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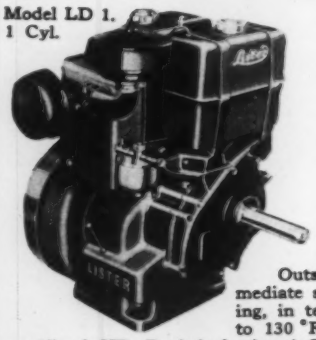
Model LD 1. 1 Cyl.



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for Primary, Auxiliary and Emergency Power

Simple, durable, amazingly compact engines. Outstanding adaptability. Immediate starting, complete air-cooling, in temperatures from sub-zero to 130 °F. Surprisingly low weight per diesel HP. Real fuel-misers! Quick, easy installation.

Model LD1 1 cyl. *3½ HP @ 1800 RPM Only 24½" high, 22" wide
Model LD2 2 cyl. **7 HP @ 1800 RPM Only 28" high, 25" wide

*5 HP Gross Rating **10 HP Gross Rating

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Circle 609 on Page 19

Stepless VARIABLE SPEED

INFINITELY VARIABLE
Zero-Max
CONTROL DEVICES

- Change speeds instantly
- Change speed any time
- All speeds zero to maximum
- Full power at all speeds
- Over 250 models and types

Rated at 60 in. lb. torque, (max. ½ h.p.) delivers stepless speeds from zero to ¼ input speed with full rated torque at any speed. Lever control standard, screw control optional. Available with various input and output shaft arrangements and rotation. This heavy duty unit also available in a motorized package.

- With or without reverse
- With or without gearhead
- With or without motor
- 1/30 through ¾ h.p.

Special models and Application data available. For complete information write for Bulletin MD 458 TODAY

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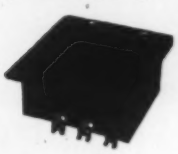
Severest Electrical Services

P-506-CE—Plug with Cap



S-506-DB
Socket with deep Bracket

JONES PLUGS & SOCKETS
500 SERIES
Proven Quality!

For 5,000 Volts, 25 Amperes per Contact Alterable by circuit Characteristics.

Socket contacts of phosphor bronze, knife-switch type, cadmium plated. Plug contacts hard brass, cadmium plated. Made in 2, 4, 6, 8, 10 and 12 contacts. Plugs and sockets polarized. Long-leakage path from terminal, and terminal to ground. Caps and brackets, steel parkerized (rust-proofed). Plug and socket blocks interchangeable in caps and brackets. Terminal connections most accessible. Cap insulated with canvas bakelite.

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HOWARD B. JONES DIVISION
CINCH MANUFACTURING CORPORATION
CHICAGO 24 ILLINOIS
SUBSIDIARY OF UNITED CARR FASTENER CORP.

Circle 611 on Page 19

specify ATLANTIC METAL HOSE

Atlantic flexible metal hose is JOB TESTED & CERTIFIED to withstand the most extreme conditions of temperature, pressure and rough usage. Wall thickness is absolutely uniform. Atlantic hose cannot kink, deteriorate or burst—and requires no maintenance.

Available in steel, bronze, monel and various alloys of stainless steel with proper fittings.

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Type A-1 Corrugated-Size 3/16"-4" I.D.

Type SW Corrugated-Size 1"-20" I.D.

ATLANTIC METAL HOSE CO. INC.
318 Dyckman St., New York 34, N. Y.

Circle 612 on Page 19

See This

ZENITH ELECTRIC CONTROL EQUIPMENT At BOOTH 469

Program Timers

Automatic Reset Timers

Interval Timers

Process Timers

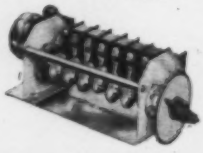
Explosion-Proof Timers

Zenith Automatic Control Equipment provides a full line of the most accurate and reliable timing devices available to industry. This precision-engineered equipment features field-proven design, simple construction and . . . most important . . . years of completely dependable maintenance-free service.

Whatever your timing requirement . . . program, interval, reset, multiple circuit, process or explosion-proof . . . remember that Zenith is the recognized specialist . . . also day or calendar switches, automatic and remote control switches, contactors and all types of special electrical control equipment.

Write for latest Bulletin

See classified telephone directory for local distributor.



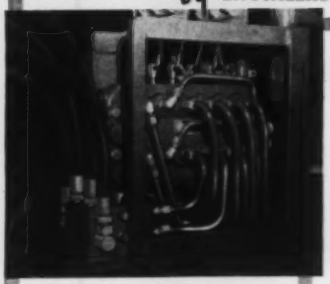
Multicircuit Timers

ZENITH ELECTRIC CO.

149 WEST WALTON STREET • CHICAGO 10, ILLINOIS

Circle 613 on Page 19

EASTMAN FLUID POWER LINES *Designed and Developed* by ENGINEERS for ENGINEERS



Eastman
"O" Ring Boss Fittings with Back-up Washer to prevent "O" Ring Extrusion

Eastman engineers cooperated in the pilot application of hydraulic hose assemblies on the power unit of this Sherman Power Digger shown above.

For full payload power—from lever to load—consult first with Eastman—"first in the field" of Hydraulic Hose Assemblies.

It pays to submit your original specifications for your first quotation to Eastman.

Write for . . .
Adapter Bulletin No. 500

Eastman MANUFACTURING COMPANY
Dept. MD-4C, Manitowoc, Wisconsin

Circle 614 on Page 19

MAYLINE

THE LATEST IN DRAFTING EQUIPMENT!

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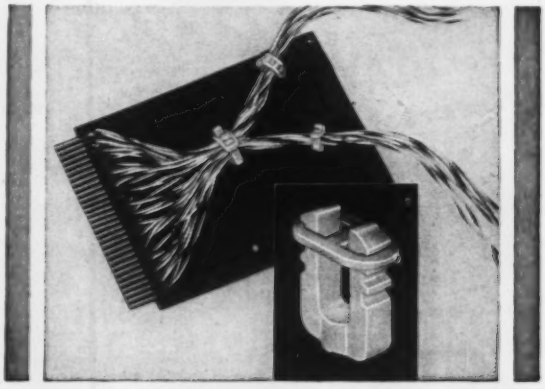
See on display our complete line, including pedestal and 4-Post tables in steel and wood, plan files in both steel and wood, straightedges, kits, and stools. You will find our exhibit interesting!

MAYLINE CO., INC.
601 No. Commerce St.
Sheboygan, Wisconsin

MAYLINE

Circle 615 on Page 19



new Zytel wire clamp cuts weight in planes and missiles

This unique wiring clamp weighs only 0.001 lbs. for 3/16" capacity handling 58,000 circular mils . . . only 0.052 lbs. for 2-1/2" capacity handling 8,570,000 mils. It resists fatigue in any position, and withstands loadings up to 50 g's. Easy installation—place wire bundle between U-shaped horns; push down the keeper—it locks, with permanent holding power. Sizes range from 3/16" to 2-1/2" across the horns.

for further information request data sheet,

DAKOTA
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6641 Crenshaw Blvd., Los Angeles 43, California

Circle 616 on Page 19

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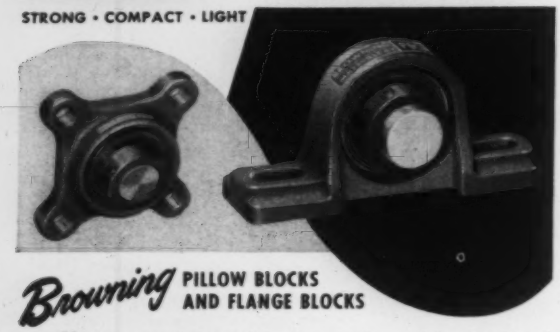

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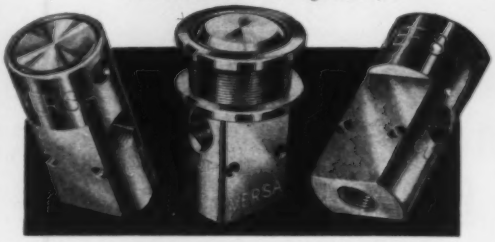

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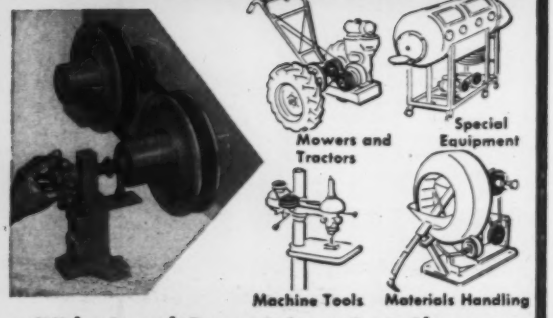

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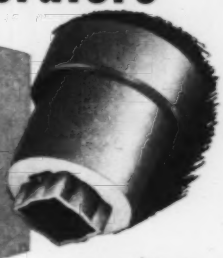

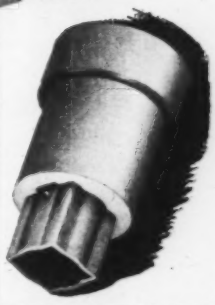

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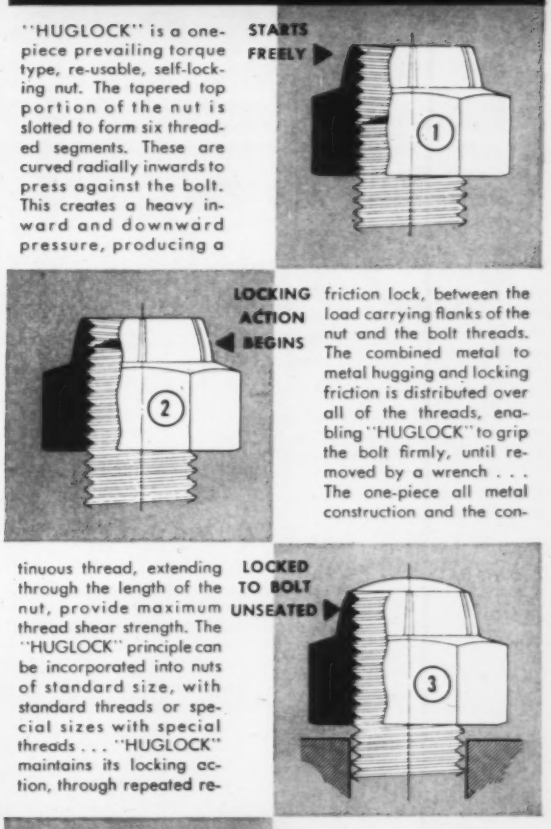

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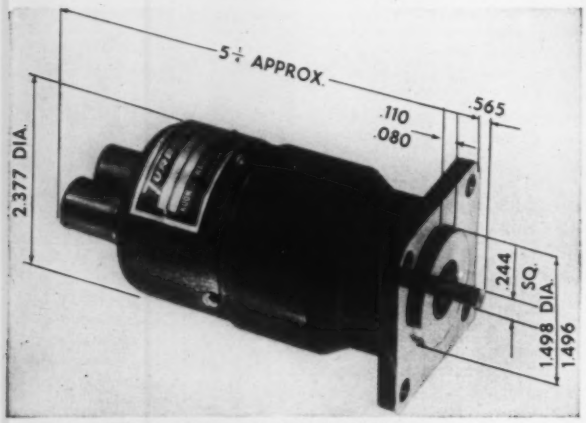

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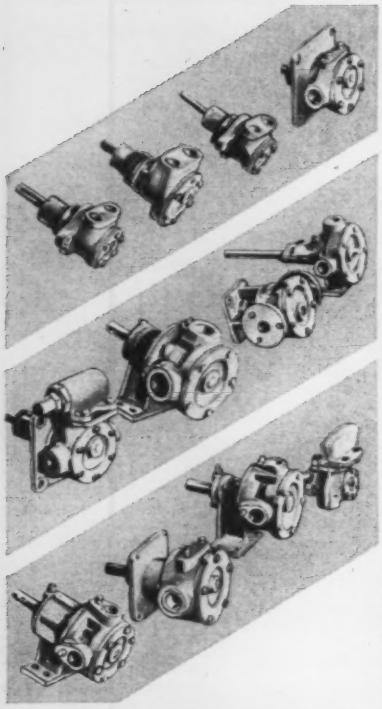

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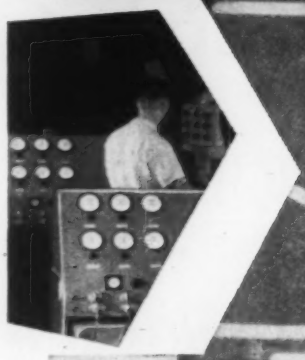

You can grow up with this fascinating electronics business at AC—a leader in the electronics industry. For AC offers you the opportunity to work with other top-flight engineers on electronic equipment for a wide range of important projects—from guided missiles to jet engines—for the armed forces and industry.

You'll move ahead in an atmosphere of personal security and progress. For AC, like all of General Motors, follows the enlightened practice of encouraging the full development of individual talents.

If you are a graduate engineer with three to ten years' technical experience in the electronic, electrical, or mechanical fields, or in gyroscope design, it will pay you to get in touch with the people at AC-Milwaukee. Just write Mr. Cecil E. Sundeen, Supervisor of Technical Employment, Dept. C, 1925 E. Kenilworth, Milwaukee 1, Wisconsin.

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AC SPARK PLUG THE ELECTRONICS DIVISION OF GENERAL MOTORS
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Producers of: AChiever Inertial Guidance Systems . Afterburner Fuel Controls Bombing Navigational Computers Gun-Bomb-Rocket Sights . Gyro-Accelerometers . Gyroscopes . Speed Sensitive Switches . Speed Sensors Torquemeters

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TALK TO THE MEN WHO KNOW THE ANSWERS . . .

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CONTROL and ACTUATING SYSTEMS

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Memo to a Show-bound Engineer

SEE THESE ITEMS IN CLEVELAND-FARVAL BOOTH 121
AT THE DESIGN ENGINEERING SHOW IN CHICAGO'S INTERNATIONAL AMPHITHEATER

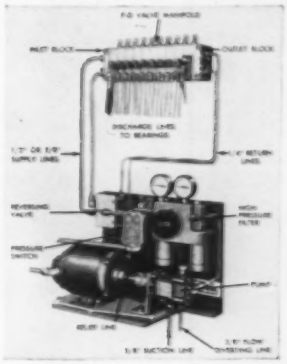
LUBRIVAL — a revolutionary new system to supply and circulate oil

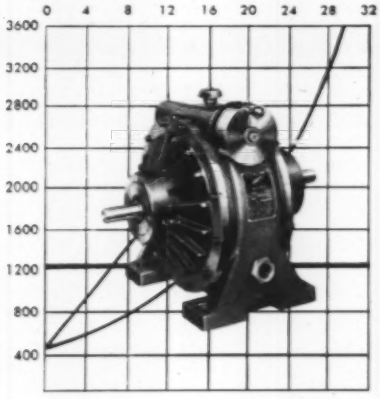
Lubrival is specifically designed for low volume, high pressure circulating lubrication of presses, automatic and semi-automatic machine tools and other machines designed for circulating oil systems.

Lubrival is a Farval system, employing the Dualine principle of delivering oil to measuring valves which pass it under pressure to bearings. Lubricant is force-fed by positive piston displacement. Flow can be regulated over a range of 10 ounces to 1 gallon per minute.

Lubrival Progressive Dualine Valves, manifolded in any number required, have individual sight indicators. A pressure-sensing mechanism warns of clogged or broken lines in *any part* of the system—a feature entirely new to circulating oil systems.

The Farval exhibit at the Design Engineering Show includes a complete Lubrival system in operation, to demonstrate all features of this new method of supplying and circulating oil.





CLEVELAND VARIATOR — "The drive that's on the ball"

This unique variable speed drive gives you infinitely variable, stepless speeds up to 9:1 (from ⅓ to 3 times input speed). Precise adjustment gives instant, smooth change of output speed by either a hand wheel on the Variator or by manual or automatic remote control. Simple construction, compact, quiet running.

Power is transmitted from input shaft to output shaft through alloy steel driving balls which are in pressure contact with discs attached to the two shafts. No belts, no slippage, no complicated linkage.

Thousands of units now in use on cigarette-making machines, textile machinery, metalworking machinery, pharmaceutical and chemical processing equipment, transfer tables, conveyors and experimental and testing equipment of many types.

See production unit and cutaway model in operation in our exhibit.

WORM GEAR SPEED REDUCERS — Sized for every need

For the many advantages of a compact, right-angle drive, you use a worm gear speed reducer—and when you want top quality, complete dependability and long life, you choose a Cleveland. Cleveland manufactures a broad range of varied types and sizes of worm gear drives—speed reducer units and worm-gear sets to be built into driven machines. Most requirements can be met economically with standard units, either "as is" or with adaptations. We also develop special designs for drive units to meet special needs.

You'll see standard models of Cleveland Worm Gear Speed Reducers in smaller sizes at the Show. Our representatives in attendance will be glad to discuss your power transmission problems. Or write us in detail.

FARVAL

And if you're a stay-at-home—

Write for Bulletin 70 which illustrates and describes the new Lubrival circulating oil system, Bulletin K-200 on Cleveland Speed Variators, and/or new Bulletin 145 which shows the complete line of Cleveland Worm Gear Speed Reducers.

THE CLEVELAND WORM & GEAR CO.
3287 East 80th Street • Cleveland 4, Ohio

CLEVELAND Worm Gear *Speed Reducers*

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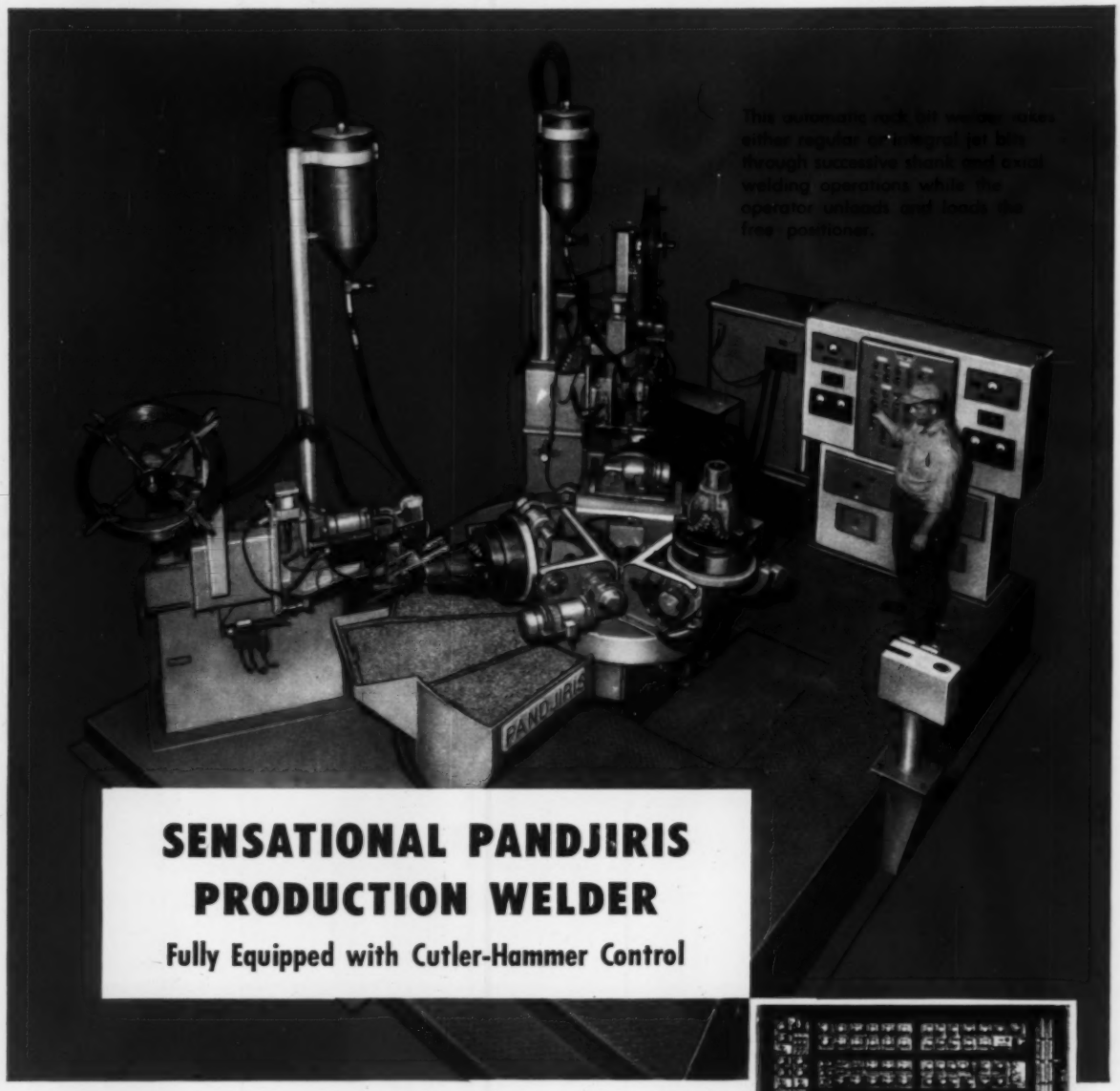


This automatic rock bit welder takes either regular or integral jet bits through successive shank and axial welding operations while the operator unloads and loads the free positioner.

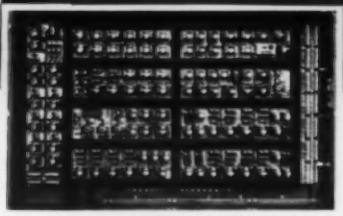
SENSATIONAL PANDJIRIS PRODUCTION WELDER

Fully Equipped with Cutler-Hammer Control

Typical of the broad trend to automation and the advanced engineering which makes it possible is the new Pandjiris AUTO-WELD-MATON* transfer type production welder for the manufacture of rock bits. Typical of automation projects, its very heart is a complex system of electrical control equipment. And typical of the best in engineering, this control equipment is 100% Cutler-Hammer.

The Pandjiris Weldment Co., St. Louis, Missouri, has long been a leader in the design and manufacture of production welding equipment, positioners, turning rolls, weld-evators, head manipulators, etc., as well as the spectacular Pandjiris AUTO-WELD-MATONS custom engineered to specific mass production requirements. Dependable performance built the Pandjiris reputation and Cutler-Hammer is proud that Cutler-Hammer Three-Star Motor Control and Cutler-Hammer Heavy Duty Oil Tight Pushbuttons are furnished as standard original equipment on all Pandjiris machines. CUTLER-HAMMER Inc., 1310 St. Paul Avenue, Milwaukee 1, Wisconsin. *Associate:* Canadian Cutler-Hammer, Ltd., Toronto.

*AUTO-WELD-MATON is a Pandjiris Weldment Co. Trademark



The electrical control cubicle contains all the Cutler-Hammer Three-Star Control components which control each machine motion.

CHOICE OF THE LEADERS

CUTLER-HAMMER

☆ ☆ ☆

MOTOR CONTROL

C-H

THE MARK OF BETTER MACHINES

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